JOURNAL

OF THE

Natural History

AND

Science Society

OF WESTERN AUSTRALIA.

The Author of each Article is alone responsible for the facts and opinions recorded.

Vol. III, No. 1—June, 1910.

Perth:
V. K. Jones & Co., Printers, Queen's Place, William Street.
1910.

PRICE - TWO SHILLINGS AND SIXPENCE.

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NATIONAL MUSEUM MELBOURNE

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1910.

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THE

Natural History & Science Society

—OF—

Western Australia.

OFFICERS 1909-10.

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PRICE : TWO SHILLINGS AND SIXPENCE.

EDITORIAL.

With the object of widening the scope of the Society it was decided at a meeting held on the 17th August, 1909, to alter the title of the Society to "The Natural History and Science Society of Western Australia." It was confidently hoped that in embracing all branches of Natural Science the Society would become a stronger and more useful body.

A regrettable delay has occurred in the publication of this number of the JOURNAL owing to the fact that although proof sheets from a type-written copy of Dr. Michaelsen's valuable paper on "The Fauna of South-Western Australia" have been available for many months, the original manuscript has only recently come into the possession of the Society. Dr. Michaelsen's paper will be published in the next number of the JOURNAL, which it is hoped will be issued early in August.

A new departure is made in publishing a Resumé of Meetings, and Reports of Excursions by the respective Leaders. In the case of the latter it is hoped that they will form a working guide to the Fauna and Flora of the various localities visited, and thus stimulate members to attend in larger numbers than has been the case during the past session.

We feel it our duty to remind members that they may greatly benefit the Society by influencing as many of their friends as are interested in scientific matters to join its ranks. With an increased membership it will be possible to publish a quarterly JOURNAL, which will be a distinct gain to the Society. We respectfully ask members to bear this matter in mind, for being one of the few learned bodies in the State the Society should do all possible to disseminate a wider knowledge of scientific matters appertaining to Western Australia.

HISTORY AND OBJECTS OF THE SOCIETY

The Society was originally founded in 1897, under the name of the Mueller Botanic Society, with Botany as the chief object of its work. It continued as such until April, 1903, when it was felt that the Society would render greater assistance in the dissemination of scientific knowledge by extending its scope so as to include other branches of Science. This was cordially agreed to, and the title was altered to the "West Australian Natural History Society," with which is incorporated the Mueller Botanic Society. Under its new name the Society continued on a somewhat chequered career by holding meetings and publishing a JOURNAL at long intervals. This was neither conducive to good work being done nor a stimulus towards bringing members together in a common cause.

Through the courtesy of the Committee controlling the Western Australian Museum, the Society held its meetings in the Museum Building until 1909,when the Society received notice from the Museum Committee that the rooms in their occupation would be required for Museum purposes. The Society was offered the use of another room, which was found to be unsuitable.

The Under-Secretary for Agriculture, Mr. T. S. McNulty, was approached, and informed of the circumstances, and on the Council requesting accommodation at the Department, this gentleman sympathetically undertook to bring the matter before the Honorable the Minister and see if it were possible to grant the privileges sought. Through the kindly interest of the Minister, the Hon. James Mitchell, M.L.A., the request was cordially granted, and the Society is now in occupation of quarters that it is hoped will be its permanent home.

The outlook of the Society has never appeared more hopeful or promising than at the present time, as in addition to a large number of old members who have renewed their interest in the Society, every meeting for a long time past has resulted in the election of new members to the roll.

The year 1909 saw the third change of title to the present appellation, so that the Society is now open to all branches of scientific research, for the frequent opportunities of discussion those subjects in which members are mutually interested, for the exhibition of specimens, and for promoting observations in the field by means of excursions.

Another sign of the interest now being shown in the working of the Society is the formation of a series of Practical Meetings for the demonstration by experts in various scientific divisions of the collection, mounting and preservation of scientific objects generally.

June, 1910.

List of Members.

HONORARY MEMBERS.

- *Diels, Dr., Grunewald, Berlin, Germany
- Forrest, Rt. Hon. Sir John, P.C., G.C.M.G., etc.
- French, Charles, Govt. Entomologist, Melbourne, Victoria.
- *‡Helms, R., Agricultural Dept., Sydney.
- *Maiden, J. H., F.L.S., Govt. Botanist, Sydney, N.S.W.
- Pritzel, Dr., Grunewald, Berlin, Germany.

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- Andrews, Mrs. Cecil.
- Alder, Miss, State School, James Street, Perth.
- Allen, F. B., M.A., B.Sc., Director of Technical Education, Perth
- *‡Allen, J. Bernard, B.Sc., Technical School, Perth.
- *Abjornsson, Inspector, Mill Point, South Perth.
- Adcock, Miss, Glyde Street, Cottesloe Beach.
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- Barugh, R. H., Havelock Street, West Perth.
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- *‡Brown, F. G., B.A., Normal School, James Street, Perth.
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- Conigrave, J. Fairfax, J.P., Hay Street, Perth.
- *‡Conigrave, C. Price, F.R.G.S., A.O.U. (Honorary Secretary), c/o Agricultural Dept., Perth.
- *‡Crossman, Alan F., B.O.U., A.O.U., Broome, N.W. Australia.
- *‡Cleland, Dr. J. Bernard, L.S., (N.S.W.), Govt. Microbiologist, Macquarie Street, Sydney, N.S.W
- *Cooke, W. E., M.A., F.R.A.S., Govt. Astronomer, Perth.
- Cooke, Mrs. W. E.
- Cumpston, Dr. J. H. L., Board of Health, Perth.
- *Creeth, Miss M. E., Hay Street, Perth.
- Despeissis, A., Agricultural Dept., Perth.
- Dyers, Miss E. M., State School, Karridale.

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Evens, E. A., Midland Junction.
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*‡Glauert, Ludwig, F.G.S., Geological Survey, Perth.
*‡Grasby, W. Catton, F.L.S., "Western Mail," Perth.
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Juleff, Mrs., Barrack Street, Perth.
Kingsmill, Hon. Walter, M.L.C., Outram Street, West Perth.
Latham, Very. Rev. Dean, M.A., The Deanery, Perth.
Lawrence, F. G., c/o Messrs. Lionel Samson and Sons, Fremantle.
*‡Lee, Thos. N., M.A., Training College, Claremont.
Le Souëf, E. A., C.M.Z.S., A.O.U., Director of Zoological Gardens, South Perth.
Le Souëf, L., A.O.U., Zoological Gardens, South Perth.
Leschen, Dr., Colin Street, West Perth.
Lipfert, Otto, York Street, Subiaco.
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Lukin, Mrs. Gresley, Havelock Street, West Perth.
*‡Maitland, A. Gibb, F.G.S., Govt. Geologist, Perth.
Maitland, Mrs., A. Gibb.
Manton, E. H., Zoological Gardens, South Perth.
‡McMillan, His Honour Mr. Justice, First Puisne Judge, Perth.
Mills, J. B., Barrack Street, Perth.
Milligan, Thos. J., Education Dept., Perth.
*‡Morrison, Dr. Alexander, L.R.C.P. & S. (Edin.), Rokeby Road, Subiaco.
Newland, P. T., Leeder Street, Leederville.
Olley, J. E., State School, Taylor's Well, G.S.R.
Petherick, H. W., Board of Health, Perth.
*‡Prinsep, H. C., J.P., Hay Street East, Perth.
‡Prinsep, Mrs. H. C.
Reegan, D. J., Zoological Gardens, South Perth.
Richards, E. P., Lands Dept., Perth.

‡Riley, The Rt. Rev. Bishop, Bishop's Court, Perth.
Robinson, Mrs. H., Albany.
*Sargent, Oswald H., M.P.S., York.
*‡Simpson, Edward S., B.E., F.C.S., Govt. Mineralogist, Perth.
Smyth, Miss J. E., State School, James Street.
Steele, Dr., Govt. Bacteriologist, Perth.
Stockwell, Fred. C., A.S.A.S.M., Technical School.
‡Thorp, Dr. C. G., St. George's Terrace, Perth.
Tilly, A. L., M.P.S., Hay Street, Perth.
*‡Tratman, Dr. Frank, St. George's Terrace, Perth.
Tratman, Mrs.
Tymms, Dr , Public Hospital, Perth.
Watkins, A. O., Royal Mint, Perth.
Whelan, T. G., Leeder Street, Leederville.
*‡Woodward, B. H., F.G.S., C M.Z.S., A.O.U., Director of W.A. Museum, Perth.
Young, G. M., Midland Junction.

JUNIOR MEMBERS.

Cook, Miss Erica.
Hickey, Master George.
Hood, Master S. J.
Woodward, Master J. H. F.

‡Signifies Members who have held office.

*Signifies Members who have contributed Papers.

Report for the Year 1908-9.

Your Council has great pleasure in submitting the Annual Report and Balance Sheet for the session ending June 30th, 1909.

The decline in membership, which has been an unhappy feature in the year, has not continued during the period under review; on June 30th, 1908, there were 48 Ordinary and 11 Honorary members, making a total of 59. Owing to resignation, two names were removed from the list on July 1st, 1908, so that the session commenced with 57; during the year 23 new members were elected, so that on June 30th last there were 80 names on the roll, making a nett increase of 21.

During the year the Council met nine times and there were thirteen General Meetings, including four excursions, being an increase of four in the number of Council meetings and eight in the number of General meetings.

The contributions read at meetings included the following:—

July Annual Meeting.

Mr. T. N. Lee, M.A., "The Corals and Physiographical features of the Abrolhos Islands."

Mr. C. Price Conigrave, "The Fauna of the Abrolhos Islands."

August.—Numerous short contributions.

Mr. H. M. Giles, F.E.S., "Dragon Flies of S.W. Australia," by Mr. R. J. Tillyard, of Sydney, N.S.W.

Mr. E. S. Simpson, "Scorodite and other New Western Australian Minerals."

Dr. J. B. Cleland, "Report on the Expedition to Port Hedland."

Mr. H. M. Giles, "Entomological notes on the Expedition to Port Hedland."

September.—

Dr. Cleland, "Heredity."

Mr. Giles, "Notes on the Entomology of the Gooseberry Hill Excursion."

October.—

Mr. Bernard H. Woodward opened a discussion on Professor Michaelsen's Paper which had just been issued to members as a number of the *Journal.*

Mr. Simpson, "Notes on some Parkerville Rocks."

November.—
Mr. Oswald H. Sargent, of York, "Colour Photography."

December.—
Examination of the specimens obtained on the Dredging Expedition.

April.—
Mr. Glauert, "Notes on the Mammoth Cave Expedition."

May.—
Mr. Oswald H. Sargent, "Biology of Marianthus lineatus."

June.—
The Presidential Address of Dr. J. B. Cleland read by the Chairman, Mr. Bernard H. Woodward.

Numerous specimens were shown by members from time to time and much interest was evinced concerning them and the remarks made by the exhibitors.

The field excursions included visits to Gooseberry Hill, Parkerville, Kelmscott, and a Dredging Expedition on the lower reaches of the Swan River. It is hoped that the excursions will be held more frequently and that all members will endeavour to make them successful.

It is very satisfactory to be able to announce that the repeated efforts made by the Society have at last resulted in the Proclamation of Barrow Island as a Fauna and Flora Reserve.

During the Session two numbers of the *Journal*, Nos. 5 and 6, have been published, whilst the manuscript of No. 7 will be in the hands of the printer before the end of the present month.

Turning to the financial position of the Society, it is necessary to point out that although £37 5s. 6d. was received in subscriptions, against £8 8s. of the previous Session, there is a loss of over £30 on the year's workings, partly due to the fact that the Government Grant was not paid before June 30th, although it has since come to hand, and partly because of the heavy cost of *Journal* No. 6, which was unusually bulky and contained several plates.

If the Society is to continue and enlarge its useful work and publish several numbers of the *Journal* yearly, it is essential that many new members must be induced to join, and it is the earnest hope of your Council that all members will endeavour, to the utmost of their power, to induce their friends to become members and assist it in the task of studying and examining and describing by means of papers and other contributions the, as yet, little known Flora and Fauna of this vast State.

(Signed) FRANK TRATMAN, CHAIRMAN.
LUDWIG GLAUERT, SECRETARY.

NATIONAL MUSEUM MELBOURNE

Statement of Receipts and Expenditure of

WESTERN AUSTRALIAN NATURAL HISTORY SOCIETY

For the Year ended June 30th, 1909.

RECEIPTS.	£	s.	d.	£	s.	d.
To Balance from last year—						
Cash in Bank	78	12	5			
,, ,, Hand	2	12	6			
,, ,, Petty Cash		17	8			
				82	2	7
Subscriptions—						
Session 1908/9 (42)	22	1	0			
Arrears (29)	15	4	6			
				37	5	6
Dredging Expedition						
Contributions from Members ...				1	6	0
Sales—						
One copy W.A.N.H.S. Journal No. 2					1	6
Govt. Grant --						
Subsidy not yet paid						
				£120	15	7

EXPENDITURE.	£	s.	d.	£	s.	d.
By Library—						
Flora Australiensis (Dulau) ..	7	9	4			
Sir Joseph Banks (petty cash) ..		5	6			
				7	14	10
Printing (V. K. Jones & Co.)—						
As per receipts, Circular, etc. ...	1	4	6			
Journal No. 5	7	10	0			
Circular and Journal No. 6 ...	20	19	8			
Circulars	1	16	4			
				31	10	6
Salaries—Mr. Bradshaw	5	0	0			
Mr. Glauert	10	0	0			
				15	0	0
Dredging Expedition—						
Hire of Launch (Sutton & Olson)				2	0	0
Bank Charges—						
Dulau's Draft		1	1			
Keeping A/c.	1	1	0			
				1	2	1
Petty Cash—						
Postages, Attendants, etc., etc. ...				11	15	5
Balance—						
Cash in Hand	3	13	6			
,, ,, Bank	45	16	6			
,, ,, Hand (dredging exped. ...	1	6	0			
,, ,, ,, (sales)		1	6			
,, ,, ,, (petty cash) ...		15	3			
				51	12	9
				£120	15	7

We have compared the above Statement of Receipts and Expenditure with the Books and Vouchers produced, and certify the same to be correct.

(Signed) H. R. COOMBS } AUDITORS.
J. W. LANGSFORD }

Perth, W.A., 22/7/1909.

Presidential Address.

The Australian Fauna and Flora and Exotic Invasions.

BY J. BURTON CLELAND, M.D.

(Read before the Society on the 29th June, 1909.)

Before the advent of the white man, the great island-contineut that we inhabit was almost unique amongst the larger lands of the earth in the long isolated position that much of its Fauna and Flora had experienced when compared with the more rapid interchanges that could occur and had occurred between those of the other continents. Zoologically and botanically speaking, for ages its characteristic animals and plants had been allowed to multiply and differentiate and adapt themselves quite free from exotic invasions from neighboring lands except in a few instances. The result has been that types, highly modified it is true, have survived in comparative abundance till to-day, that have elsewhere long been superseded by families, genera and species more suited to the strenuous life and climatic conditions of those latter times. With the advent of the white man, however, the old order changed to give place to new, and an evil train of disease, disaster and death has fallen upon too many of our indigenous animals and plants. Even already to the Naturalist it is strange and sad to look back to this fair land as it must have appeared on that 26th day of January, 1788, when the first fleet sailed into Botany Bay. The fair woods have fallen, the self-neglecting aboriginal has become a diseased and decaying creature, the wild birds have left their desolated homes, and the emu and the kangaroo are doomed. Let us look back a little and see what might have been.

In the first place the coming of the white man, possessing as he did an intelligence far superior to that evolved by the needs of his black aboriginal brother, makes it obvious that his domination over the other was merely a question of time. The mechanism was not there for the Australian native ever to be educated so as to hold his own with the European, and, save in as much as he might be kept in reserves as a curiosity stranded on the shore by the seas of time and cared for much as we tend canaries in cages, he was doomed to go to the wall. But other factors, beyond this fight between the more fit and the less fit, came into play to hasten on his extermination. The white man, when he left his home to cross the seas, left not disease behind him. With vast care, it is true, he could have left some forms behind and we might have been free from them here to-day as we are free from smallpox, glanders, typhus fever and a few others. But medical science was young in those days and the cause of many diseases unknown. Had the knowledge we possess now been known then, it is possible that tuberculosis in man, measles, scarlet fever, whooping cough and other diseases that now take heavy toll from amongst us, might have been forbidden entrance. Be that as it may, the fact remains that certain diseases, introduced by the white man, played sad havoc with the black. Tuberculosis of the lungs has carried off many thousands, certain ghastly diseases due to lax morality have destroyed vast numbers and made loathsome such as remain, while in the early days, smallpox, which has fortunately been completely overpowered, decimated vast areas and appears to have preceded the white man into the interior of the continent. A disease which appears to have been smallpox presented itself amongst the natives soon after the establishment of the settlement at Port Jackson, and would seem to have spread rapidly from tribe to tribe. Dr. Lang, in his "Historical and Statistical Account of New South Wales," first published in 1834, thus describes it :—In the year 1788 the number of the aborigines inhabiting the shores of Port Jackson was very considerable ; a disease, however, somewhat resembling the smallpox, which appears to have prevailed among them to a great extent, shortly after the establishment of the colony, thinned their ranks very sensibly, and left only a comparatively small number to inherit the invaded patrimony of their forefathers. Numerous dead bodies were from time to time found by the colonists in all directions in the vicinity of the harbour, in the very attitude in which the wretched individuals had died when abandoned by their tribe from the fear of the pestilence. There seems every reason to suppose that this disease was actually smallpox introduced by the whites.* Major Mitchell, in his explorations to the Darling in the thirties, describes how the tribes there had been almost wiped out, only a few pock-marked individuals remaining, while even an explorer in comparatively recent times mentions having met with such a scarred individual in Central Australia. The disappearance of the disease from Australia must be accounted for by the exaggerated virulence known to attend the invasion of any race by a disease they have never encountered before, and in consequence show little power of resistance against it. As the various native tribes have little intercourse with each other, the disease gaining entrance into one by some chance individual, could destroy its members in *toto* without their neighbours coming in contact with living diseased persons.

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* The actual wording in the description of Mitchell's Expedition is ambiguous. Under the date, May 28th, 1832, he describes meeting four men, a boy, and seven women and children on the Darling. He says, "most of them had the smallpox, but the marks were not larger than pin-heads." Then follows a reference to the natives having met with Sturt, ". . . . It seemed to me that the disease, which it was understood had raged among them (probably from the bad water) had almost depopulated the Darling, and that these people were but the remains of a tribe." It is difficult to decide whether Major Mitchell means by this that it was the smallpox, aggravated by the bad water, that had decimated the tribes, or some quite separate ailment. In the summary of the chapter, found at its beginning, we find, however, "Natives—Mortality among them from smallpox." If Mitchell compiled this summary himself, these words are final ; if, on the other hand, the publisher did so, the matter must remain *sub judice.*

It rests with the present white inhabitants to prevent the chance occurrence of such a devastating epidemic amongst themselves by seeing that their children are regularly vaccinated, so as to render them resistant to the disease when brought in contact with it and so as to maintain the relative immunity now possessed by the white man in comparison with the black.

A considerable mortality likewise attends the occurrence of measles amongst the aboriginal population.

Hydatid disease, which was almost certainly an introduction by the white man with his dogs, sheep or cattle, has spread far and wide and is responsible for many deaths amongst the blacks, though it does not seem more fatal in them than in the white man. They are, however, more likely to be infected by drinking contaminated water. In addition to introducing the native to diseases of various kinds unknown to him before, the white man has presented him with gifts equally fatal.

Timeo Danoas et dona ferentes. European clothes, as worn by the blacks, are notoriously unhygienic and dangerous to them, inasmuch as they are seldom discarded, but are worn day and night, become filthy in the extreme, and in wet weather become saturated with rain, in dry by perspiration. Alcohol, besides its direct injury, also increases the liability to chill.

Finally, the European has taken from the aboriginal his country and his food supply and has restricted his nomadic life, all which have told heavily upon his numbers. We have, then, as regards human beings, the following :—The exotic invasion of Australia by the white man, a race far superior in civilization (*i.e.*, in a round sense, mentally) to the aboriginal, has resulted in the latter's rapid diminution in numbers and probably speedy extermination. This result is being rapidly aided by the invasion of the virgin soil of the native by exotic diseases such as smallpox (in former times), tuberculosis, measles, hydatids, and other diseases.

ANIMALS.

The indigenous mammals of Australia are, with the exception of certain rodents and bats, the dingo, whales and seals, all marsupials, descendants of a type which in most other parts of the world has long been replaced by -or rather perhaps, modified into—other forms. In fact, these very exceptions are almost certainly not autochthonous, but represent exotic invasions, the rats and water-rats arriving for instance on logs or in canoes from neighbouring lands ; the dingo almost certainly coming with man, either with the original black man, who is also an outside invader, or with stray Malays and other folk touching on our northern shores ; the bats and sea-animals have, of course, obvious means by which they could reach Australia. These now indigenous rodents have, however, from their long sojourn in Australia, struck a mean with its other inhabitants and now play little or no part in altering the fauna numerically or qualitatively. The dingo, likewise, and the aboriginal, though taking their toll of kangaroo and opossum, have for long not materially altered the balance of nature.

But with the white man came his flocks and herds, his horses and asses, protected with peculiar care and requiring abundant pasturage. The settlers hewed the forest and tilled the soil and killed the native animals that fed upon the herbage as well as driving back mile by mile the timid ones. Cattle, sheep and horses are, in fact, a carefully fostered exotic invasion, rapidly, under man's careful hand, entirely replacing the larger native animals, though, doubtless, if left to their own accord, they would have made far less impression. The large number of buffaloes in the Northern Territory, however, show that, even when entirely wild and dependant on their preservation from extinction to their own resources only, some species of ruminants can multiply, in suitable areas, to a very large extent. The same is evidenced in many of the large cattle stations in our northern parts, where the animals are left almost entirely to themselves and are practically wild.

But, like Dean Swift's lesser fleas on little fleas, these very animals have brought with them exotic diseases, some of which, with timely forethought, might perhaps have been prevented from gaining a foothold. If the utmost care had been taken in the first instance and if knowledge in those days had been as advanced as it is now, we might have been to-day free from tuberculosis in cattle, from swine-fever, from the tick-fever or redwater of cattle and the tick disease of fowls, from anthrax, etc. We have, so far, by quarantine and careful examinations, prevented surra from gaining a hold, as well as rabies (hydrophobia), foot-and-mouth disease in cattle, rinderpest and various other less-known animal diseases. Had buffaloes not been introduced into Northern Australia, we would have been now free from tick fever in cattle; if, within recent years, it had been ascertained that poultry, when imported, came only from places where the fowl-tick (Argas) did not exist, our fowls would not now be suffering so frequently from the disease transmitted by these parasites; swine-fever might have been similarly evaded.

The exotic animal invasions so far discussed have been designed invasions and have not transgressed the limits of control. There are, however, some which, though originally intentional, have become of great economic importance from the vast numerical increase of their members. The rabbit is a case in question. Originally let loose in the hope that they would breed and form objects for sport as well as furnish something for the table, they have multiplied beyond all conception, having so few enemies with which to contend and such a genial climate to live in. Already have they swept almost across the continent and have caused losses of many millions of pounds. Not only is there the loss from herbage devoured, but a still further one from the disturbance of the soil, a very serious matter especially in sandy country.

The inexcusable introduction of the fox for sporting purposes has led to his rapid multiplication in parts of Victoria, South Australia, etc., and the loss of many sheep. Cats have become wild and, near Perth for instance, fierce and powerful in build, feeding on the native birds and smaller animals and rabbits where these are present.

The introduced rats (*Mus norwegicus*, the Norway Rat, and *Mus alexandrinus*, the old English "black rat") seem not to have extended beyond man's more immediate surroundings. The dominant rat in Perth is the sociable black rat, the larger Norway rat being only hitherto obtained from the neighborhood of the wharves at Fremantle and Perth. It is otherwise in Sydney, however, where both are found together in the town. These rats have brought with them several species of fleas, of which some will bite man when their original host is absent (*e.g.* has died). By this means another exotic disease, the plague, introduced by the rats, is communicated to man.

The sparrow, the starling, the goldfinch, the blackbird, and the Indian mynah have all come to stay. Some of these eat much grain and fruit, while all tend to drive away and usurp the place of our beautiful interesting and useful native birds. I am glad to say that the only foreign bird I have seen flying free in Western Australia was a single chaffinch or green-finch.

I need hardly refer to such exotic insect pests as the bed-bugs, the fruit-fly and the codlin-moth. The stable-fly (*Stomoxys calcitrans*) is a comparatively recent arrival in Perth and is ominous, not only on account of its painful bite, but also because it is a known transmitter of certain trypanosome diseases such as surra. Horse-bots naturally came with horses.

We have already paid heavily for the introduction of certain ticks, such as that (*Margaropus annulatus*) of tick fever of cattle and the fowl-tick (*Argas pestilis*). As regards mosquito-borne diseases, both malaria-transmitting mosquitoes (Anophelines) and filaria-transmitting ones (Culicines) are to be found near Perth, though the former of the two is not common. So far, however, we have not the diseases transmitted by either. In the presence of the mosquitoes, nevertheless, is seen the possibility of the establishment of both malaria and filaria (elephantiasis) in the southern parts of Western Australia should persons arrive harbouring the respective parasites and be bitten by many of the transmitting mosquitoes. In Brisbane, filarial worms can now be found in the blood of a large percentage of the people, the disease being transmitted by the local mosquitoes from imported cases at the beginning.

PLANTS.

In the vegetable kingdom we have some most unfortunate exotics. The bulbous wire-grass is replacing all herbage in the Cannington District. The prickly pear (*Opuntia*) in Queensland now covers extensive areas and is costing large sums to eradicate. Star-thistles (*Centaurea calcitrapa*) and Stinkwort cause trouble in places. Some of the Queensland rivers have been choked with the water-hyacinth. Let me offer a solemn warning to the people of Western Australia. Some unscrupulous person has already introduced the plant, which has beautiful heads of flowers, and the rock-pools at Mount Eliza are full of it (or were so when I left the State), and some of the swamps at South Perth and in North Perth are simply covered with it. By design or accident, it is sure in time to enter various of our rivers and reservoirs and there, spreading rapidly, cover them with vegetable growth which, decaying in masses and harbouring all kinds of life, would soon render reservoir water undrinkable and rivers unnavigable. Imagine Mundaring Reservoir built at such enormous cost and on whose supply of water so many depend, covered with this growth!

CONCLUSION.

In conclusion, I may say that it has been the endeavour of this paper to indicate the very grave dangers that may attend inadvertent exotic invasions from parts over sea. I have tried to show how some of the ills we now suffer from might have been avoided by more carefully excluding from or scrutinizing the introduction of certain living things into Australia. And I shall feel satisfied if this paper helps in any way to protect us in the future, by calling attention to the imperative need of thoroughly and scientifically supervising every possible chance by which danger is threatened — from the undesirable alien, the malaria-stricken dweller from the tropics, to stock and wild beasts, to fruits and vegetables, plants and seeds, to cage birds and insect-pests and even to pounded bone and horse-hair from anthrax-infected areas. The decay of Greece, once supreme in all the Arts and Sciences, followed in the track of the malaria-mosquito and she fell from her high estate attacked by unknown and insidious foes to become a people almost contemptible, lethargic and anaemic. May we be warned in time to despise nothing and to see the fates of Empires hanging in the bites of gnats !

Meetings of the Society.

The Annual Meeting of the Society was held at the W.A. Museum on Tuesday, the 13th July, 1909, when the Vice-President, Mr. A. Gibb Maitland, F.G.S., presided over a good attendance of members.

Mrs. Daisy M. Bates, F.R.A.S., and Dr. Steele were elected members of the Society.

The Annual Report and Balance Sheet were presented and duly adopted.

The election of officers for the ensuing year took place, and resulted in the election of the following:—President, Dr. Tratman; Vice-Presidents, Mr. A. Gibb Maitland and Dr. Morrison; Treasurer, Dr. Thorp; Council, Messrs. F. G. Brown, H. M. Giles, E. S. Simpson, Thos. N. Lee, W. Catton Grasby; Honorary Secretary and Librarian, Mr. C. Price Conigrave; Honorary Auditors, Messrs. J. W. Langsford and H. Raymond Coombes.

The question of the revision of the rules was dealt with.

The Ordinary Monthly Meeting of the Society was held at the Museum on Tuesday, the 17th August, 1909, when the President occupied the chair, and a large number of members were present.

The Rules, as printed elsewhere in this JOURNAL, were adopted.

The Ordinary Monthly Meeting of the Society was held at the Museum on Tuesday, the 14th September, 1909, when the President occupied the chair, and presided over a good attendance of members. The Patron of the Society, His Excellency the Governor, Sir Gerald Strickland, was present.

The following were elected members of the Society:—The Hon. Walter Kingsmill, M.L.C., Mr. D. J. Reegan, Mrs. W. E. Cooke, and Miss Erica Cooke as a Junior Member.

Mr. C. Price Conigrave recorded the finding of a specimen of the Crested Penguin (*Cataarhactes chrysocome*) on Rottnest Island, near Fremantle.

The President communicated the description by Mr. J. H. Maiden, F.L.S., the Government Botanist of New South Wales, of two new Western Australian Eucalypts.

Dr. Alexander Morrison read a paper on "Adaptation of Plants to Environment," which was illustrated with lantern slides. At the conclusion of the paper, His Excellency pointed out that to his mind Dr. Morrison had touched on three most interesting questions, viz., the grasses, fodder plants, and the inadaptibility of irrigation to the special conditions of large areas in Western Australia.

Mr. W. D. Campbell, A.K.C., F.G.S., read his report on the Armadale excursion, and showed lantern slides to illustrate his remarks. The exhibits included geological specimens secured at Armadale, and Co-Types of several new species of Western Australian THYNNIDAE by Mr. H. M. Giles, F.E.S.

The Ordinary Monthly Meeting of the Society was held at the Museum on Tuesday, the 13th October, 1909, when the President occupied the chair and a large number of members were present.

The following were elected members of the Society:—Misses Amy V. Fuller and M. E. Creeth, Messrs. Oswald H. Sargent, R. H. Barugh, and as Junior Members, Messrs. S. J. Hood and George Hickey.

Mr. W. E. Cooke, M.A., the Government Astronomer, spoke of the astronomical matters as touched upon by the Paris Congress, from which he had recently returned.

The exhibits included live specimens of three timber-feeding beetles, the genus of one being unknown, and several females of the Fossorial Wasps (*Mutilla rugicollis*) by Mr. H. M. Giles.

The Ordinary Monthly Meeting of the Society was held at the Museum on Tuesday, the 9th November, 1909, when the chair was taken by the President, and a fair number of members were present.

The following were elected members of the Society:—Mrs. Gresley Lukin, Messrs. P. T. Newland, E. H. Manton, and W. E. Cooke, M.A., the Government Astronomer.

Reports of excursions to Boya, Cannington, Statham's and Smith's Mills were read by the Leaders, Dr. Tratman, Dr. Thorp, and Mr. E. S. Simpson, respectively.

The Ordinary Meeting of the Society was held at the Technical School on Tuesday, the 14th December, 1909, when the President occupied the chair, and a large number of members were present.

The following were elected members of the Society:—Messrs. F. R. Dymes, M.A., F. C. Stockwell, A.S.A.S.M., and Mesdames H. Robinson and S. J. Haynes.

The President reported that the Museum authorities required the rooms that the Society had occupied for several years, and consequently arrangements had had to be made for accommodation elsewhere. It was hoped that the Society would find a permanent home at the Technical School.

A report on the excursion to Carnac Island was read by the Leader, Inspector Abjornsson, who also contributed notes on the spawning of the Schnapper (*Pagrus unicolor*).

Mr. E. S. Simpson, B.E., F.C.S., contributed a paper, illustrated with lantern slides, on "Some Avenues of Research open to Natural History Students in Western Australia." Mr. Simpson dealt in an interesting manner with Foraminifera and Diatoms. Mr. Simpson's paper will appear at length in the next number of the JOURNAL.

Reports of Excursions.

MUNDARING WEIR, 14TH AUGUST, 1909.

The first of the Society's excursions for the current session 1909-1910 was fixed to take place on Saturday afternoon last, and the scene of work was the region of the Mundaring Weir, in the Darling Ranges, whither a total of eight Members journeyed. Before going further, I may be pardoned for expressing the opinion (not my own) that the attendance of members was not at all satisfactory. Members who were absent will, I trust, take the hint and roll up for future excursions. I think all will agree, however, that as far as the Officers of the Society are concerned, the excursion was a success, for although the trip was the first one after their taking office, five of the eight taking part were office-holders, and although their captures were not as large as could have been wished, I think it shows a happy augury for the future welfare of the Society, and I am sure you will agree with me that if this state of things continues, the Watchword of Nature and Science—"Onward" will be the guiding star, as it were, of our humble Society. But if young and humble now, need we remain in this form? Rather, should we not strive and endeavour to let this small nucleus grow and expand into something worthy of a more fitting appellation?

Unfortunately, the journey up from Perth was considerably delayed through an irksome wait at Midland Junction, which was the means of considerably shortening the all-too-brief stay in the vicinity of the Weir. On arrival at our destination a hurried move was at once made for a promising gully through which the Hay Creek flows into the Weir. The only sign of wild mammal life was a solitary Black-gloved Wallaby (*Macropus irma*), generally known as the "Brush," but the interview was very brief, as he seemed to have a more pressing one in the hills, judging by his haste to arrive there.

Ornithology presented us with far more representatives, which, I am very glad to say, were all allowed to remain in peace, as no specimens were wanted on this occasion. Of the two most numerous species noted, one was the ubiquitous Magpie (*Gymnorhina dorsalis*). I suppose this unfortunate name (Magpie) will stick to this bird indefinitely, although members are well aware, I am sure, that it is one of the Crow-Shrikes or Butcher-birds and not a true Magpie at all. It is very interesting to note the extreme variation in the white colouring of this species. It would be most difficult to get two specimens marked alike—

perhaps impossible. The two most extreme cases I have seen personally are at the present time living in the South Perth Zoo: one is a true albino, while the other almost represents melanism, as it only has a very small patch of grey on the dorsal surface. The second species noted in the locality, and which, by the way, is found commonly in all parts of the South-West, was the "Twenty-Eight" (*Barnardius semitorquatus*). Here again is another species of widely varying plumage, which time will not allow me to enter into, but if you will observe them carefully you will find some of them having a very distinct frontal band of red, another shows it as a faint narrow bar, in others again it is quite absent; again with the breasts of different specimens the coloration is equally as striking (in speaking of "breast" I mean lower breast as well); some, as you will perceive, are light green, another yellowish green, others quite green. Some have a broad yellow band across the lower breast and I have observed a few with the breast almost deep yellow. I have mentioned these observations, not to poach on the preserves of our Ornithological members, but in the hope that I may be able to stimulate someone to take up these facts and see if they cannot bear me out, because I cannot refrain from saying, that apart from the scientific value of such a series of good skins, an equally unknown item of deeply interesting scientific knowledge is awaiting publication. And who are better able to do it than those living in company, so to speak, with the creatures themselves?

Our Ornithologists may retort, "Why don't you keep to your Insects?" So I may reply "I could give many reasons, but I think two will do, firstly, with Nature as a companion I have never been able to go about with my eyes shut; secondly, it is an intense love of our feathered friends, as part of my business, that enables me to notice these things, and suggest its publication, because the standard work of the immortal Gould, "The Birds of Australia," simply says, and the British Museum Catalogue corroborates: "breast light green or yellowish green," while Hall's "Key to the Birds of Australia" is not only brief but almost obscure. I give it in full: "*Barnardius semitorquatus* – head brownish-black, frontal band red; abdomen green."

A solitary specimen of the White-fronted Heron (*Notophoyx novæ-hollandiæ*) was observed perched on a rock near the Boat house, evidently waiting for its next meal to come along. The other few species we noted comprised the Scarlet-breasted or Campbell's Robin (*Petræca campbelll*), two Diamond Birds (*Pardalotus punctatus*). These latter were observed in an ideal spot wherein to find their nest later on. A few White or Silver-eyes (*Zosterops gouldi*) and the misnamed Tomtits (*Acanthiza inornata*) were busy amongst the Wattle bloom (*Acacia baileyana*). Both these latter birds are, without exception, two of the most valuable of Insect destroyers that we have in the State, although the first is most cruelly maligned, because he likes a little fruit, and is consequently slaughtered in thousands. Were it only possible to do away with this species for only two years we should have its ignorant judges offering golden premiums to have the valuable little bird back again. It may be of interest to some to learn that the last species was busy with household affairs last July 22nd in the Zoological Gardens. The nest was well nigh completed in a Christmas Tree (*Nuytsia floribunda*) but I regret to say that the recent gales have almost obliterated the tree; and the builders, not appreciating such rude hints, have gone to seek safer quarters elsewhere.

A few Brown Honey-eaters (*Glycyphila ocularis*) were also busy among the Wattle bloom, and though denied a sight of it, the clear, distinct ringing note of the Singing Honey-eater (*Ptilotis sonora*) betrayed its presence among the Hakea blossoms in the gully. The most interesting sight to me was a solitary White-browed Spinebill (*Acanthorhynchus superciliosus*) poising itself on the wing while extracting the nectar from a large Kangaroo-paw (*Anigozanthos manglesii*), an attitude strongly suggestive of the large Hawk-moths. The eleventh and last species of the feathered tribe noticed was the Pallid Cuckoo (*Cuculus pallidus*) and I would suggest that we might derive much interest, as the Victorian naturalists have done, by carefully recording the earliest dates of arrival in each year of this interesting wanderer. Unfortunately, I can only find two (I thought I had more) and they are wide apart: August 3rd, 1905, and July 21st., 1909.*

Insect life was excessively scarce, if one omits the usual W.A. exceptions: Flies, Ants, and Termites or white ants, as most people will persist in calling them, despite the fact that they are not true ants, but belong to a totally different Order – *Neuroptera*, or Nerve-winged Insects. The only Lepidoptera noted was a freshly emerged Admiral Butterfly (*Pyrameis itea*), and one or two specimens of a medium-sized Geometer Moth (*Hydriomena correlata*, Wlk.), but as they were in such wretched condition we left them in peace. A few specimens of our small metallic-green Forester Moth (*Procris viridi-pulverulenta*) were on the wing. This is exceptionally early for this species, as it seldom appears before the end of this month, and it is generally September ere one meets with it.

The Coleoptera did not favor us much better, as we only succeeded in taking eight species, whereas, if members recollect, we took forty-one last August on the Society's excursion to Gooseberry Hill. Our captures comprised three Caribs (*Chlænius greyanus*) and *C. marginalis* and *Promecoderus scauroides* I believe it to be, but of this I am not yet sure. Staphylinidæ yielded two species of Paederus, which are undetermined. The very common Weevil (*Moloctus gagates*, Pas.) proved as numerous as ever; Chrysomelidæ gave us *Paropsis granaria*, which were all we succeeded in getting at Mundaring, but during our journey home a very small specimen of *Coptocercus aberans*, Newn, flew on to Dr. Thorp's coat, thus ending its career and furnishing our only Longicorn. This is indeed a widely distributed pest.

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*This year the bird is earlier than usual, as we heard it on May 28th and several again on June 8th.—(Editors).

On arriving back at the Weir we were met by a friend who had noticed our arrival, and who presented us with a tin box containing what he informed us was "one of your extraordinary pets." It turned out to be one of the large carnivorous Bugs (*Reduvius* sp.). Perhaps it would be well to advise members to use caution in handling any of this tribe, should they chance to meet with them, as they are able to inflict a most painful stab with their stout beak; the agony resulting therefrom is excruciating, and lasts from four to six days, especially so with *Pirates ephippiger*, a common and widely distributed species, upwards of an inch in length, of a dull black color, with rather stout reddish-brown legs, and a conspicuous heart-shaped patch of pale yellow behind the scutellum. I have seen persons bitten by this species hardly able to contain themselves in their agony. The wound is distinctly visible as a dark crimson spot. If you have not been bitten, from personal experience let me advise you "not to," as I much prefer being stung by two or three Bull-dog Ants (*Myrmecia vindex*, Smth.) if I am allowed the choice.

We were on the look-out for specimens of the "fossorial" Hymenoptera, but none were met with, again illustrating the seasonal difference, as at Gooseberry Hill last August we collected two species new to us, with two or three of the commoner forms.

Although many species of Diptera (Flies) were in evidence, we did not devote any time to them, as we had another object in view, but we could not help observing one species we had not met with previously on account of the "habit and position"; that is, almost every flower of the bright canary yellow *Craspedia richea* had one, and in some cases, two specimens of that very handsome but dreadful pest, the Mediterranean Fruit Fly (*Ceratitus capitata*) on it. Both sexes were observed but only very few males. It is certain that they do not breed in it, but resort to it as a source of sustenance alone.

The above finishes the Insect life taken, as we were devoting our attention more to the less-sought-after "Cryptozoic" forms of life, but although we worked hard at log and stone turning, our reward was poor indeed, as we only met with three specimens of Planarian worms of two species which belong to the genus *Geoplana*, *furco-dorsalis* and *quinquelineata*. We were more fortunate in numbers with our special object, *Peripatoides gilesii*, Spencer,* as upwards of twenty specimens were obtained between us. As so many keep enquiring, What is a Peripatus? it may not be out of place to give a brief outline of the creature in this report, but for a full description I must refer you to Professor Sedgwick's excellent works, "A Monograph of the genus Peripatus" and "A Monograph of the Development of Peripatus capensis," from which the following is extracted: "The genus Peripatus was established in the year 1826 by Guilding, who first obtained specimens from St. Vincent in the Antilles. He regarded it as a Mollusc, being no doubt deceived by the slug-like appearance given by the antennæ. Specimens were subsequently obtained from other parts of the Neo-Tropical Region, and from South Africa and Australia, and the animal was variously assigned by the Zoologists of the day to the Annelidæ and Myripoda. Its true place in the system as a primitive member of the group Anthropoda was first established in 1874 by Moseley,† who discovered the tracheæ. And there can be no doubt that Peripatus is an Anthropod, as it possesses features so characteristic of that group. Finally, the tracheæ, though not characteristic of all the classes of Anthropoda, are found nowhere outside that group, thus constituting a very important reason for uniting Peripatus with it. Peripatus, therefore, is, zoologically, of extreme interest from the facts that, though in the main, Anthropodan, it possesses features which are possessed by no other Anthropod, and which connect it to the group to which the Anthropods are in the general plan of their organisation most closely related. It must therefore, according to our present lights, be regarded as a very primitive form, and this view is borne out by its extreme isolation, even at the present day. Peripatus stands absolutely alone as a kind of half-way animal between the Anthropoda and Annelida. There is no gradation in structure within the genus, and the species are limited in number."

Since the last clause was written by Sedgwick several zoologists have divided them up into different genera as under:—Peripatus as the original name is retained for the Neo-Tropical species, Peripatoides and Ooperipatus for the Australasian species, Peripatopsis and Opisthopatus for the African, Paraperipatus for the New Britain, and Eoperipatus for the Malayan species. And I may say, taking them in the same order, the number of claw-bearing legs is very striking, the Neo-Tropical 28 to 43 pairs are found. The Australasian species 14 to 16 pairs. The African 17 to 25 pairs. New Britain 22 to 24 pairs, and, lastly, the Malayan species with 23 to 25 pairs. For a general description one cannot equal Sedgwick's, which is as under: "Peripatus, though a lowly organised animal and of remarkable sluggishness, with but slight development of the higher organs of sense, with eyes the only function of which is to enable it to shun the light — though related to those animals most repulsive to the aesthetic sense of man—animals which crawl on their bellies and spit at, or poison their prey—is yet, strange to say, an animal of striking beauty. The exquisite sensitiveness and constantly changing form of the antennæ, the well rounded plump body, the eyes set like diamonds on the side of the head, the delicate feet, and, above all, the rich coloring and velvety texture of the skin all combine to give these animals an aspect of quite exceptional beauty."

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*Description of a new species of Peripatoides from Western Australia, by Baldwin Spencer, M.A., C.M.G., F.R.S., Professor of Biology in the University of Melbourne. Proceedings of the Royal Society of Victoria, Vol. xxi. (N.S.) pt. II., pages 420-423.

† "This is an animal of the very highest importance and antiquity, and I believe it to be a nearly related representative of the ancestor of all air-breathing Anthropoda, *i.e.*, of all Insects, Spiders, and Myriapods."—H. N. Moseley. Proc. R.S., Lon., 1874, Vol. xxii., pp. 344-350, "On the Structure and Development of *Peripatus capensis*."

You will have seen from the above that it would be useless looking for these animals in open exposed daylight, if you want to see them at home —you must seek them under logs (for preference) looking well into any crevices, into which they are fond of squeezing themselves, then you may be gratified by the sight of what you may take to be a caterpillar, but if you look closely you will find it has antennæ—which no caterpillar has, also that its legs are in regular pairs and with our particular species 16 pairs, so that it has good specific differences from the Eastern forms, which have only 15 pairs. Each leg also terminates with a foot, bearing sickle-shaped claws, quite unlike the true caterpillar with its 6 true legs and 4 pairs (in general) of prolegs or claspers. They are sluggish in movement in daylight, yet very active by night or when in dark crevices. They are extremely variable in color, varying from a greenish black, umber brown, brown, to rich chestnut, very variable in size and length, especially when extended in crawling. Sedgwick's reference to "spitting" is on account of their habit of ejecting a quantity of very tenacious slime from the oral papillæ, which firmly adheres to everything (so far tried) except the skin of the creature itself. It is beastly stuff to get off one's fingers.

A few Centipedes and Millipedes were taken, but as they will have to go home for identification, we can give no particulars about them at the present time.

I rather hesitate to say much about the plant life noticed, still as no Botanical member was present one is expected to furnish a few notes. One thing appealed very strongly, as illustrating "climatic difference" in some 557 feet of elevation. One of the silver-foliaged Wattles (*Acacia baileyana*) which is at the Weir (elevation 420 feet above sea-level) had just finished blooming, getting quite shabby, in fact, but higher up at the No. 2 Pumping Station (elevation 755 feet) the trees were in full perfection of bloom, while on top of the hill at the Mundaring Railway Station, elevation 973 feet above sea level) they had scarcely commenced to bloom. Here was an object lesson in striking character almost compelling notice. The principal masses of bloom were furnished by two species of Acacia and two of Hakea, which we did not know the names of, and foolishly forgot to bring along specimens for identification. The lovely native Traveller's Joy (*Clematis macrophylla*) was just donning its starry wreaths, while *Kennedya nigricans* and *K. prostrata* and *Hardenbergia comptoniana* made glorious masses of contrasting colors, but these, beautiful as they are, do not appeal to me as does the almost heavenly blue of *Leschenaultia biloba*, one of the purest of blues on our landscape. Many more most beautiful genera such as *Hovea*, *Pimelea*, *Chorizema* and *Hypocalymna* were just commencing to open, and in a fortnight's time would be worth the journey to see. We also found the season too early for the Orchideae, as we only saw a few early specimens of *Diuris*, *Pterostylis*, *Prasophyllum*, and *Caladenia*. A few specimens of the *Pattersonia limbata*, Family Irideae, we observed among hosts of other species and varieties not enumerated, as also the two Kangaroo Paws (*Anigozanthos humilis* and *manglesii*) .

I should like to suggest that Botany forms one of the objects of each of our excursions, as I think it would be of great scientific value if we could register the times of flowering, if not of the whole, at any rate of the Orchideae. Also, can we not arrange to have an exhibition of wild flowers alone, arranged scientifically, and set apart one night for such during this and each succeeding year ? I am sure you will agree that it would be of the greatest interest to us all, particularly so, if, as I say, the specimens were arranged in scientific sequence, with their names attached.

H. M. GILES.

ARMADALE, 4TH SEPTEMBER, 1909.

The members attending proceeded by the 1.20 p.m. train to Armadale, on the Perth-Bunbury railway, a distance of 19 miles. Mr. Coombe's quarry, the objective of the visit, is close to the boundary of the township, and about one-third of a mile south-east from the railway station, the route being along William Street to the main Perth-Bunbury road, and thence about nine chains along the tramline from the brick kilns to the quarry. The railway station is 179 feet above sea-level and the quarry is about 100 feet higher by barometer. The quarry, which was commenced about seven years ago, is an excavation into the slope of the Darling Range, the granite outcropping a few chains further up the hill. The quarry face has a height of about 70 feet. The material that is being quarried consists largely of a dark slate which strikes 4' and dips 65' west. (See plate No. 1, Fig. 1.) The

Fig. 1.

Fig. 2.

NATIONAL MUSEUM MELBOURNE

latter is a view of the south end of the quarry, the dark shales being towards the downhill side The inner face of the quarry is an oxidised clay and kaolin which is used equally with the shale in the making of bricks, the various kinds of material being mixed together in the pugging mill. At the south end the material is kaolin with bunches of quartz veins in it up to 18 inches diameter. The quartz is somewhat cavernous and chalcedonic. The surface of the kaolin in dry seasons shows an efflorescence in places which is both magnesian and saline. On the western margin of the quarry, at the head of the tramline, there is a diorite dyke passing in a north-westerly and south-easterly direction, some large loose boulders lying on the surface adjacent represent the weathering of the dyke, while the excavation shows the solid material. No actual intersection of the shales of the quartz is to be seen at present, but it would not be improbable to occur, for quartz veins penetrate the sandstone at Donnybrook about 100 miles to the south, and diorite dykes intersect the quartzites or altered sandstones near Moora, about 100 miles to the north. The kaolin spur here is probably a decomposed spur of the granite range. The shale is contorted in places and has, moreover, an incipient cleavage which is perpendicular and thus intersects the bedding plane at an oblique angle (see plate No. 1, Fig. 2).

The age of the strata above described has not yet been determined, and they may or may not be of the carboniferous period. The material is favorable for the preservation of organic remains such as graptolites ; these range up to about one inch in length, and it is to be hoped that members of the Society will keep a watchful look-out for any such traces, as the quarry work proceeds.

W. D. Campbell.

BOYA, 18th SEPTEMBER, 1909.

Boya is situated on the Chidlows' Well line, some twenty miles from Perth. It is a good place for work, being little frequented and with most picturesque surroundings. There is here plenty of material for all branches of Natural History. A quarry in which a dyke of diorite is exposed was examined. This was pointed out by Mr. Simpson and its formation explained.

The botanical collections were good, including some fine specimens of an Orchid (Prasophyllum elatum), which in this neighborhood can be obtained up to 2½ feet in height.

F. Tratman.

Boya Entomological Notes.—Entomology was very poorly represented, as the whole of the ground covered by the excursionists had been very severely swept by bush fires during the last summer, so that while we walked and worked hard, few captures were made Still, we were not altogether disappointed, for our first glimpse of the locality told us the well-known tale;—"It is almost useless to expect to meet with other than very scanty numbers of Insects for two years at least after these severe fires." At the close of the afternoon, in making a detour to arrive at the Railway Station, we came across about an acre of scrub which had escaped the fire, and this yielded us a large number of Insects. Here also we were favored with a sight, seldom seen except by the patient and observant entomologist, of the way in which the Ichneumon flies oviposit into the larvae of the timber-destroying Longicorn beetles. The species furnishing the illustration was one of the largest Braconidæ (Bracon sp.) not previously met with, and unknown to me, about an inch and three-quarters in expanse of wings, with an ovipositor an inch and a half in length. The head and prothorax are orange in color, eyes and antennæ black, thorax black, wings smoky brown, first pair of legs reddish, second and third pairs black, abdomen shining black with four to five narrow pink bands, anterior part of abdomen with large patch of pink on sides and underside, making it a very handsome insect indeed. We were fortunate in capturing two males and three females. The male is much smaller than the female, as is usual in this Order. As soon as these insects locate the position of the intended victim in its gallery or tunnel, the ovipositor is forced through the bark and wood, until it pierces the skin of the larva, when an egg or eggs, as the case may be, is extruded into it. In a few days the minute larvae are hatched and commence to feed on the unfortunate host, carefully avoiding the vital organs, until it has attained its full size, or else they form the concluding part of the living banquet, after which these cannibals seek a place close to the exit of the gallery and spin a large silken pupal chamber of a leathery nature, greyish white but sometimes yellow in color, in which they remain until the following spring before emerging. All these females had the ovipositor inserted to its full length into the trunk of a "White gum" tree. After watching them for a time they were carefully captured, this being a risky proceeding to withdraw this exceedingly fine instrument without injury to it. A person of ignorance would probably leave the ovipositor and part of the abdomen in the tree.

H. M. Giles.

CANNINGTON, 2nd OCTOBER, 1909.

Fourteen members attended this excursion. On arrival at our destination the party divided into sections, one going under Dr. Tratman's leadership, their special quest being Botanical specimens, the remainder of the party, under Mr. Giles, devoting themselves to Entomology. Both these gentlemen will report on their respective divisions.

I myself am still in the junior student stage, only recently having resumed an active interest in biological matters. I have decided to take the "Droseras" as my speciality. I think it would help to interest members and conduce to good work being done if individuals or groups specialised in the different branches. We should then soon have authorities to whom our finds might be submitted. I found one species of Drosera at Boya, which I have at home, where it appears as if it meant to flower. I also got another on this excursion. I have tried to preserve the flowers by placing them in a solution of Formalin, but regret to say that the experiment was unsuccessful, so I have nothing to report on my own special branch.

At Cannington, Dr. Tratman kindly gave me some plants of Byblis, an interesting genus closely allied to the Droseras and especially interesting as there are only two species, the most beautiful of which (*Byblis gigantea*, Lindl.) occurs here.

C. G. THORP.

BOTANICAL NOTES.—This proved to be a good excursion for botanists, as the swamps held plenty of water and yielded a good number of Utricularia and Polypompholyx, as well as "Sun-dews" (*Drosera*), and the swamp-loving Prasophyllum. *Byblis gigantea* is plentiful here, but on this occasion was not in flower, though one member had seen it in flower a week before in another locality. Among Orchids, Caladenia, Diuris and Eriochilus were plentiful, and one single individual of *Pterostylis barbata* was collected.

In this neighborhood a botanist finds sufficient of interest to while away many hours without walking more than ¼ mile from the railway station.

FRANK TRATMAN

ENTOMOLOGICAL NOTES.—Insect life was very scarce owing to the cold and wet weather conditions which had been prevailing for some days previous to our visit, which retarded their appearance, so that what few insects we did get required a lot of searching for and shaking of bushes. Coleoptera yielded five species not previously met with, viz., a fine Diphucephala, two Curculios, one Clerid, and one Chrysomelid.

Lepidoptera, with the single exception of a few very worn specimens of the Painted Lady Butterflies (*Pyrameis cardui*, var. *kershawi*) were not in evidence, other than in the larval or pupal stages; a few of the large silken cocoons of *Darala censor's* were brought back for us to hatch out, also two or three of the closely protective-colored cocoons, Cosmotriche sp. These latter are placed in crevices of the rough bark of the Casuarina trees (on which the caterpillars feed), which they so closely resemble that they are seldom observed.

Hymenoptera had hidden themselves away in the warmest places they could find, but nevertheless we discovered two species of the Fossorial genus, Thynnus, with their anomalous females which resemble Ants, new to our collection. Five females of the closely allied family, Mutillidæ (*Ephutomorpha rugicollis*) were also secured, but unfortunately no male specimen could be found, even after a long and patient search. A few Tabanid Flies and Pentatomid Bugs comprised all the remainder of the insects secured for an afternoon's work.

H. M. GILES.

MUNDIJONG, 3RD OCTOBER, 1909.

On the journey back from Cannington yesterday, the President, Dr. Tratman, suggested that it would be a graceful act on the part of Dr. Thorp and myself if we would arrange to go to Mundijong to locate a certain Eucalypt tree, which our late President, Dr. Cleland, had drawn attention to on several occasions, as being unique, if not quite new to Science. Mr. Maiden, of Sydney ,had examined leaves from this identical tree, and he was not satisfied from these that the tree was of a known species. The Right Hon. Sir John Forrest had, it seems, years ago, noticed this tree as being one quite out of the common, although nothing appears to have been done at the time to throw definite light upon the subject.

The President added that it would be of great benefit to members if they were enabled to go direct to the tree instead of having to search for and locate, and probably miss it, during the limited time that would be available on the Society's excursion set down on the syllabus for January 8th, 1910. Accordingly, Dr. Thorp and myself were happy to act on the suggestion, and accordingly visited Mundijong as stated above. The tree was found close to the point of intersection between the Mundijong road and the main Perth-Bunbury road. Owing to the immense height of the tree it was found possible to get a few leaves only. From appearances the tree is not likely to flower for several months. Without the flowers it will, of course, be impossible to determine the exact species. In any case both Dr. Thorp and myself think it would be highly desirable to request the Government to strictly reserve the tree.

Owing to the beautiful warm day, we found Insect life much more numerous than on the previous day at Cannington. Although our finds included numerous common species, we were fortunate in securing many which proved unique Amongst Coleoptera we took five specimens of a very fine Scarib (*Bolbocera* sp.) which is unknown to me. To capture these particular specimens it necessitated considerable digging operations with "bayonet and tomahawk." As these were the only weapons we had, we had to make the best of them. These Insects burrow into the ground to a depth varying from about one foot to sometimes two feet, and then lay several eggs which after a time become larva and feed on the roots of various kinds of vegetation until they attain their full development, when they assume the pupal stage, and pass into the perfect state, only to again renew the cycle.

We secured a few specimens of the scarce Buprestid (*Stigmodera simulans*), which is very rarely captured, and near the celebrated tree, was a spring of water issuing from the hill above, which on investigation, yielded a few specimens of Water-beetles of the family Dytiscidæ, strangers to us, and, unfortunately, very small. A few specimens of Elaters and Longicorns (*Trichomesia newmani*) and the rare *Ommophæna tæniata* formed the bulk of the Beetle life taken.

No Lepidoptera were taken, as what few we saw were either common or much worn. We came across a fine patch of *Verticordia acerosa* in full bloom, and spent some considerable time examining it, which resulted in our adding five species of Thynnidæ, that we had not previously met with, to our collection. All these are correctly sexed, besides a series of each species. We also secured five other species, four of which are fairly common, but the fifth species makes only the second pair captured I cannot give the name yet, but will do so later on, as the species is "new to Science" and is now being described by the British Museum Specialist (Rowland E. Turner, Esq.) from my first pair taken at Kelmscott in 1907, which will be the TYPE specimens. A few Scoliid Wasps and Native Bees completed our captures in this vast and interesting Order.

We had not gone on Entomology bent, as you will have seen; we had our mission to do, and after completion of that we found that there were still several hours to spare. The Naturalist is unlike so many people with whom one meets, who complain of having "to kill time" (his trouble is to find time enough for his purpose), and consequently we commenced to gather in the bye-products, as it were, which in the case of this Excursion were amply satisfying, as, besides those specimens mentioned, we got many other things well worth the journey.

It is to be hoped that a goodly number of Members will attend the proposed excursion to this locality on January 8th next, when we will be able to guide them direct to this interesting Eucalypt, which we all hope will prove to be unknown to Science. After the party has satisfied themselves with a sight of this fine tree, we will hope to enlist their help in unearthing some more of Nature's gems in this locality.

H. M. GILES.

SMITH'S MILL, OCTOBER 16TH, 1909.

On the 16th October the Society made an excursion to Smith's Mill, when the Botanical, Entomological and Geological sections of the Society were all represented. In the unavoidable absence of Mr. A. Gibb Maitland, F.G.S., the leadership devolved upon myself.

On arrival at Smith's Mill the party necessarily divided, the entomologists proceeding to the South-east, the rest of the party to the South-west. In preparing the following notes, I am indebted to our President for the botanical information and to Mr. H. M. Giles, F E.S., for the entomological.

GEOLOGICAL —In the gravel pits and brick pits immediately to the South-west of the station the structure of the widespread laterite capping and its relationship to the underlying white clay and granite is rendered obvious. The laterite consists usually of bauxite and limonite in about equal proportions, in one place at Smith's Mill it was seen to contain so little iron as to become a sufficiently pure bauxite to be used for the commercial production of aluminium. At a short distance on either side it passes gradually into a much more highly ferruginous material.

The origin of this laterite is a problem of great interest which is only now being solved. So far as this part of Western Australia is concerned its origin appears to be as follows:—In the wet winter season rain water charged with carbonic acid penetrates to a considerable depth into the granite, which it attacks, converting it slowly into a mixture of quartz and kaolin and dissolving all alkalis, magnesia, lime, iron and part of the alumina. In the dry summer seasons as the water in the surface soil evaporates, the mineralised water from below rises to the surface and evaporating there deposits all its mineral matter. Of this latter the hydrates of iron, aluminium and titanium remain permanently as a laterite cap, whilst the magnesia, lime and alkalis are carried away by surface waters.

Proceeding westward along the railway, granite and occasionally diorite or diabase dykes are seen in the cuttings. The granite contains much microline and in two places includes a narrow pegmatite vein in which microline is very plentiful.

About half way between Smith's Mill and Darlington the surface effects of a fault are to be seen. This fault passes under the railway line at a small angle and brings to the surface at this point a large quantity of water charged with silt, the result being a very insecure foundation for the line which has in consequence, constantly to be repaired.

The party proceeded to Darlington, but time did not permit of the examination of the interesting belt of mica schist occurring in the granite there.

Botanical.—On this day two beautiful Orchids were especially prominent, being in full bloom. They are both tall many-flowered *Thelymitras*, one -*crinita*—is blue, the other —*villosa*—is yellow. The *Leschenaultia biloba* formed large patches of blue on the railway embankment, where also were found handsome plants of the *Gompholobium polymorphum* and many other flowers of the Order Leguminosae.

Diuris and *Caladenia* in the neighbourhood were beginning to fade and their seed capsules to enlarge. On the slopes of the hill above Darlington station, where the excursion terminated, the tall olive green *Prasophyllum elatum* is especially plentiful at this time of the year, up to 5 ft. 6 in. in height.

Entomological.—The entomologist of our party, Mr. H. M. Giles, F.E.S., has found Smith's Mill to be, on the whole, a poor collecting ground at all times of the year. One gully to the North-east of the station, had proved on previous occasions to be the most interesting locality, but on this occasion was found to have suffered, like so many other places, from the severe bush fires of last summer. The total number of captures was not therefore very large.

The Coleoptera comprised two small Caribs, *Bembidium sp.*, four Melolonthids of the genera Diphucephala, Phyllotocus and Liparetrus. The Buprestidæ were poor in numbers but yielded two fine specimens of *Stigmodera gratiosa* taken on the blooms of a Styphelia. This most brilliant and strikingly coloured beetle is very rarely taken in this district. The limits of its range southwards has not yet been determined. *Stigmodera elongata* was also taken. It is common along the coast near Perth and for some distance inland. Two species of *Melobasis*, *M. gloriosa* and an undetermined species comprised all of that Family. A few small Curculios (Weevils), Chrysomelidæ, and *Lagria cyanea* completed our list of this Order. Several cocoons of *Micropœcila breweri* were brought back for subsequent hatching.

We were on the alert for "Fossorial" Wasps, but only succeeded in taking two species each of Thynnidæ and Scoliidæ, all well known.

A few specimens of native Bees were encountered. One species not previously met with greatly resembled in colour the flowers of Daviesia sp., on which it was feeding.

Diptera were not specially sought for, but a few specimens of a Tabanid so persistently sought our collector that they were transferred to the killing bottle.

One Bombylid fly was also seen.

Planarians. Several fine specimens of the Planarian worms of two species, viz., *Geoplana fusco-dorsalis* and *quinquelineata*, were unearthed from the heart of a decaying Blackboy, (*Xanthorrhoea preissii,*) which they had evidently chosen as a retreat in which to pass the long hot and dry summers, finding not only the moisture which is so essential to them, but also a food supply from the larvae of the numerous flies and beetles which breed in them. Mr. Giles states that when searching for the latter he has frequently found these worms in them, sometimes five and six in a bunch, during January and February. Any of you who have dissected these blackboys then will know the moist condition which prevails in the central area of them during the earlier stages of decay. Many years ago when talking with Dr. Arthur Dendy, who was making a special study of these animals, he told Mr. Giles that "one of his chief problems was to know where they got to in the summer time and how they managed to exist during the long dry spells." As it is not known whether anyone has solved this problem so far, perhaps this hint may be of some value to those interested in these creatures.

E. S. Simpson.

ZIG-ZAG (STATHAM'S) EXCURSION, 30TH OCTOBER, 1909.

The excursion to Statham's quarries, on the Upper Darling Range Railway, was attended by a record number of members for this year. After being over-carried by the train to a point half a mile above the quarries, the party scrambled down the hill to the latter point, in the immediate vicinity of which the remainder of the afternoon was spent. As in the previous case, I am indebted to the President and Mr. H. M. Giles for notes regarding their particular provinces.

Geological.—The geological structure in this locality is similar to that at other points along the western escarpment of the Darling Range, viz., massive grey granite intersected by dykes of diorite. In the quarries a large dyke and a small offshoot have been opened up over a considerable area and to a depth of 50 or 60 feet. A small fault in the centre of the larger dyke was represented by a narrow band of foliated rock in which were some very thin veins of Stilbite and Calcite. A specimen picked up on the floor of the quarry showed that these veins occasionally expand to ¾ inch in thickness. This is the first recorded instance of a Zeolite being found in one of these greenstone dykes in the Darling Ranges.

Entomological.—Insects were scarce after the cold wet weather of the previous day or two. Mr. Giles had been looking forward to capture one or two species of small "Skipper" butterflies known to inhabit this part, but not one was seen, and it is probable that they will be scarce this season, as their haunts have been so severely swept by last season's fires. The cosmopolitan Painted-lady (*Pyrameis cardui*, var *kershawi*) was the only species noticed. The only moth taken was a nice fresh specimen of one of our Emeralds (*Euchloris sp.*). This is a genus of the Geometer moths, having the wings of various shades of green, averaging about an inch in expanse of wing, and are lovely little objects much sought after by collectors. Several were disturbed, but the wind and rough ground prevented capture.

Coleoptera were numerous in a few species we did not want, but scarce in good things. We took a few specimens of the smallest examples of the Longicorn, *Eroschema atricolle* we have met with. They are of interest from the fact of being just about half the ordinary size. There is little doubt but that this is the result of the bush fires consuming the food plant (*Styphelia* sp.), or, rather, the portion above ground, thus cutting off supplies, and producing this stunted development. The eggs of this beetle are deposited near the summit of the main branches of the food plant, and as soon as the small larvæ emerge, they eat through the bark into the wood, and work their way downwards. As soon as the gallery is long enough to contain them the little fellows turn round, and carefully plug up the hole by which they entered, to prevent attack from the rear by small Ants, and Hymenopterous parasites. The plug is made of fine shavings of the wood cut on purpose, and is very firm and secure. When thus secured from attack they again turn and make their way downwards to the roots, packing away the excreta resulting from the consumed wood into the gallery behind them. On reaching the secure haven of the root, they construct a chamber larger than the gallery, as a refuge to retreat to when danger threatens from above. This chamber and the lower part of the gallery to a space of about six to eight inches above the ground is kept quite free, so as to give quick passage either way, as once this retreat is provided they enlarge it to the size required by their growth, using the remainder of the inside of the wood of the branch as a food, so that in many cases nothing but the bark is left, when numbers are broken off by the winds, cattle walking amongst them, etc. As soon as this happens the larvæ set to work and plug it up as described above. Fires sometimes burn off all the wood above the ground without roasting the half-grown larvæ in the roots. These have then no alternative but to construct the pupal chamber and change into the perfect state, or die. The tenacity of insect life is astounding in some species and instead of dying we get these stunted abnormal specimens, which, strange to say, do not appear any earlier than those which have been fully matured.

A few Cleridæ, Nitidulidæ and Chrysomelidæ comprised all the beetle life taken.

It was not an ideal day for Hymenoptera, so the small number of species did not surprise us. We took one species of Fossorial Wasp not previously met with, and a very rare Native Bee, this being only the third time we have taken it—each time one solitary individual. Three species of Saw-flies, not previously met with, were also captured, but, as is inevitably the case with new or rare things, two species are solitary females, whilst the third species comprised two female specimens.

BOTANICAL. -This journey was remarkable for the large number of Stylideae or "TRIGGER PLANTS" which were in full bloom, no less than thirteen different species being collected.

A young plant of the Native tobacco (*Nicotiana suaveolens*) was discovered in its favourite haunt, which is the shelter of the large granite boulders on the tops of the hills. It is a handsome plant, reaching to 18 inches in height, but does not blossom until January. A specimen of *Lhotzkya* was found. This genus has the characters of *Calythrix*, but without the long points to the calyx lobes. Everlastings are now coming out in great numbers and would form a very interesting study for anyone who wishes to take up a special subject.

E. S. SIMPSON.

CARNAC ISLAND, 10TH SEPTEMBER, 1909.

On Friday, December 10th, 1909, thirty members of the Society, including thirteen ladies, and the President, Dr. Tratman, left Fremantle in the Government launch "Waratah" for Carnac Island, which lies seven miles to the south-west of Fremantle Harbour.

After a pleasant passage, we reached our destination at 7.45 p.m. Having landed the passengers, the launch returned to Fremantle. Tea and more substantial refreshment was soon provided in the old quarantine quarters in the centre of the island. The weather was delightful, with a gentle southerly breeze to cool the air. Most of the party spent the night in the open, the ladies having a comfortable camp quite close to the water's edge. Some of the sterner sex assisted Mr. Giles, our enthusiastic entomologist, in capturing the insects that collected around a burning hurricane lamp. I myself managed by means of a drift net to catch about five dozen fish, chiefly herring, and these came in very well for breakfast on Saturday morning. Included in the catch were two interesting fish* quite new to me, and to our W.A. Coast. They are now being examined by the authorities of the Australian Museum, Sydney.

Early on the Saturday morning a start was made with a party in each dinghey to explore the outlying reefs and rocks. Unfortunately, the reefs were all submerged, with the exception of the narrow edge fringing the windward side of the Island, hence very few specimens of interest were obtained.

Fortunately, the weather was calm and the sea smooth, so every place of vantage was visited, and with the aid of a water

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*Wrasse or Herring-Kale (*Olisthops cyanomelas*, Rch.) (Ann. Mag. Nat. Hist. (2) Vol. vii., 1851, page 291.

glass the parties were able to view the beauties of the sea bottom on the rocks and ledges under water. Six Mutton birds were found sitting on one egg each, and two eggs were taken.

Several photographs of the reefs and other geological features were obtained. In the afternoon the launch returned from Fremantle and with a small party aboard we proceeded to Sulphur Bay, Garden Island, and tried dredging with a small dredge in eleven fathoms of water, but the gear proved unsuitable for that depth. A few specimens of Echinoderms, shells and other objects were, however, secured.

Returning to Carnac Island for afternoon tea, we eventually reached Victoria Quay at 7 p.m., after a very pleasant excursion.

A. ABJORNSSON.

CANNING BRIDGE, JANUARY 22ND, 1910.

Saturday, January 22nd, was the date fixed for the Society's excursion to Canning Bridge, under the leadership of Dr. Steele. Owing to his unavoidable absence, the furnishing of this account has fallen to my lot, and I am sorry to say that I am not able to give a very glowing report. In the first place there was no need to put on an extra boat, as you may be surprised to learn that the Society was represented by only four members, so they found plenty of room in the regular ferry boat.

Nothing of interest was noted on the trip down the river, as the boat travelled too fast to enable us to take notice of any marine life. We had decided en route to cross the river and work back along the eastern bank to South Perth, so no time was lost on arriving at Canning Bridge jetty, in carrying out our plan, particularly as we saw nothing to tempt us to stay on the western side of the stream. Hardly anything of interest was met with as far as Botany was concerned, although one member, Mr. A. J. Hall, was on the alert for spoils. We passed some dense patches of *Jacksonia*, sp., in full bloom, which we searched for Insect life, but all that we got for our labor were a few very small common Buprestid beetles (*Cisseis*, sp.), which were unappreciated and allowed to remain. Some *Leptospermum*, of which a few bushes still remained in bloom, yielded a few Thynnid and Scoliid wasps, but the *Lhotzkya*, sp., which was in full bloom, proved far more attractive to Insect life, as we secured eight species of the genus *Stigmodera*, including the male of *S. conspicillata*, which is excessively rare, as also the yellow ground form of *S. yarrellii*. Many species of "Pentatomid" bugs were also common on this latter, also various Diptera and Hymenoptera, but the scrub here is too well patronised by many fine and handsome species of Arachnidæ (Spiders) to please an entomologist, for their glutinous airy scaffolding continually fouling one's face neither conduces to comfort nor poetical language on his part.

A few of the handsome "native bees" (*Podalirius emendatus*), *cingulatus*, and I believe *aeruginosus*, were captured on the bloom of a small species of *Goodenia*. Our best capture was the rare and undescribed female of one of the Fossorial wasps, *Agriomyia albopictus*, Sm. The male "Type" is in the British Museum, named by Smith in 1859. I captured a male specimen again in 1901, and have taken one or two specimens at long intervals since, but although I have diligently searched, it has been labor in vain on my part for nine years. This may seem a striking fact to those who are not workers in the cause of Science, whereas they are so used to disappointment that when they do meet with success after the long weary search and waiting, it is their reward for having followed Nature's devious ways with such patience and observation.

H. M. GILES.

NORTH BEACH, 5TH MARCH, 1910.

Owing probably to the trying weather experienced during the previous few days only seven members attended this excursion. The rendezvous was left at a few minutes to one o'clock and the party proceeded in two buggies via Charles Street and the Wanneroo and North Beach Roads.

The route lay for the most part through the narrow belt of Tuart forest which extends along the west coast from a few miles north of Perth to the vicinity of Busselton. Some fine specimens of this tree (*Eucalyptus gomphocephala*) were noticed. The road runs in a northerly direction for seven miles over hills of drift sand, then turns sharply towards the west, where it soon runs into country occupied by the coastal limestone.

North Beach was reached at twelve miles from the Perth Town Hall, the time taken en route being 1½ hours. At North Beach the foraminiferal limestone of the Coastal Series forms a low line of cliffs broken by little sandy beaches. The sand on the latter appears to be mainly vitreous quartz with a fair proportion of shell fragments. No foraminifera were seen in the single sample brought back. In this respect it differs essentially from the sand on the beaches of the islands off Fremantle.

Several species of sponges were seen on the beaches, also numerous shells. These, however, did not prove of great interest to the Conchologist of the party, Mr. Bardwell, who was prevented by the high tide from securing living specimens.

Some speculation has been indulged in as to the age of the fossils frequently associated with the coastal limestone. They occur in bunches under conditions which make it doubtful whether they are contemporaneous with the formation of the rock or deposited in crevices therein more recently. Some of the fossils at Cottesloe appear to be contemporaneous. At North Beach all I examined were plainly of later date. The fossils have collected in pot holes in the rock and there become cemented with fine sand and secondary calcite, subsequent degradation of the whole rock mass leaving them exposed in various places. The fossils include numerous shells, apparently of recent species and several corals. Two of the latter which were collected are of the *Astraea* and *Meandrina* types respectively. Masses of coral of many pounds' weight were seen in these deposits and must have been derived from reefs near by.

On the wind-swept slopes just above the beach seeds of *Didiscus coerulea* were collected. This plant bears a beautiful lavender blue flower and is interesting in being one of the few native plants which grow readily from seed and thrive well under ordinary garden conditions. It is an annual. From seeds collected at Garden Island, where it grows most luxuriantly, I have grown this plant successfully in my garden amongst other annuals for several years. Seeds sent to Sydney have done well in the sandy soil of the Eastern States.

After a most exhilarating bathe followed by tea and home-made-scones, the return journey was commenced at five o'clock. The return was not without incident, the front axle of one buggy breaking when still about five miles from our destination. Most of the party were able, however, to find accommodation in the remaining buggy, whilst the balance availed themselves of the kind offer of a telephone line repairer to bring them in in his cart.

E. S. Simpson.

JANDAKOT, APRIL 2ND, 1910.

This excursion was attended by four members, and proved rather uninteresting and disappointing. Proceeding by train from Fremantle, the party alighted at Jandakot, and a careful search failed to be productive of any objects of interest. The shore of Bibra Lake was examined, and proved equally disappointing after the long hot walk. Frogs were the only sign of life noticeable.

H. M. Giles

Note on Mr. Maiden's Paper on "Records of Western Australian Botanists," which appeared in Journal No. 6.

Mr. J. H. Maiden, F.L.S., Government Botanist of New South Wales, the author of the above contribution, which appeared in the last number of the JOURNAL, did not see a proof of that paper, owing to an unfortunate oversight. Mr. Maiden was not responsible for the excerpts being made from the paper from the Royal Society of New South Wales by him.

On two new Western Australian Species of Eucalyptus

By J. H. MAIDEN, F.L.S.,
Government Botanist, Sydney, N.S.W.

(Communicated to the Society 14th September, 1909.)

Eucalyptus Woodwardi, n. sp.

One small patch seen, 120 miles east of Kalgoorlie, Transcontinental Railway Survey. Collected by Henry Deane, M.A., M.Inst.C.E., Consulting Engineer, May, 1909.

A tree of 40-50 feet, bark smooth, somewhat scaly at the butt, all parts very glaucous, almost mealy, (except perhaps the oldest leaves). The foliage contains a good deal of a not very agreeably smelling oil.

Arborea 13-15 m. (40-50 pedes) alta, cortice glabro base rimosiore, glaucissima.

Folia matura crassa rigidaque, late lanceolata, petiolata circiter, 10-15 cm. longa, 4·5 lata, inconspicue venosa, venis lateralibus angulo circiter 45° approxime parallelis.

Alabastrum magnum, pedunculatum, subcostatum, calyce urceolato, operculo hæmisphærico rostro obtuso. Antheræ cellis parallelis adnatis glandula magno dorso.

Fructus urceolatus vel prope campanulatus, subcostatus, circiter 15 mm. longus, similis in maxima latitudine, margo prominens, 5-valvulis, valvularum apicibus aequis cum orificio.

Videtur *E. incrassatae* varietati *angulosæ* et *E. cæsiæ* forsan approximanda.

Juvenile leaves.—Not seen in the early stages. In an intermediate stage petiolate, ovate to ovate-acuminate, venation distinct though not very prominent, midrib channelled, lateral veins making approximately an angle of 45° with the midrib and roughly parallel, intramarginal vein at a considerable distance from the edge.

Mature leaves.—Very thick, rigid, and glaucous, both sides of the leaf identical, nearly symmetrical, petiolate (petioles about 2 cm.), broadly lanceolate or ovate-acuminate, tapering to a not very fine point, commonly 10-15 cm. long by 4-5 broad, midrib distinct, usually thickened margin, venation fine and not readily made out, but very similar in position to that of the intermediate leaf.

Buds and flower.—Buds large, pedunculate, calyx and operculum slightly ribbed, calyx urceolate, the operculum hemispherical and tapering rather abruptly into a blunt beak. Flowers not seen expanded, but anthers removed from three-quarter ripe buds, have parallel cells joined together for their whole length, and with a large gland at the back.

Fruits.—On rounded common peduncles about 15 mm. the pedicels about 5 mm. ; up to 7 in the umbel, each fruit sharply separated from the pedicel, urceolate or nearly bell shaped, about 15 mm. long and the same in greatest width ; rim well defined, 5 valved (in the specimens seen), with the tips of the valves flush with the orifice.

In honour of Bernard Henry Woodward, Director of the W.A. Museum and Art Gallery, Perth, who, by the supply of photographs and specimens and in other ways has helped me in my monograph of this genus.

Its closest affinity appears to be with :—

1. *E. incrassata,* Labill. var. *angulosa,* Benth.

But *E. incrassata* and its varieties have foliage glabrous and even shiny, except that the juvenile foliage is sometimes slightly glaucous. Its inflorescence is sessile on a broad flat peduncle, while the buds are more ribbed, the operculum more tapering ; the fruits also are more cylindrical, usually more ribbed, and the valves are sunk.

The anthers are a good deal similar (and indeed to anthers of other species of the same group).

2. *E. cæsia,* Benth.

This species was collected by Drummond and is imperfectly known, only buds, fruits and leaves being available. We have Bentham's description, and until *E. caesia* is again collected (so far as I know only Drummond has found it), we must be in doubt as to some of its relationships. But as compared with *E. Woodwardi,* the leaves are very much smaller and less coarse, the fruits are much larger and constricted a little at the orifice and not widened at the orifice (bell-shaped) like *E. Woodwardi.*

There is less ribbing of buds and fruit. Furthermore in *E. caesia* there is a very broad, smooth rim. The two species are closely related, but I think that they are quite distinct.

Its relations with some other very glaucous species may be indicated as follows

3. *E. miniata,* A. Cunn.

This species has also the buds more or less ribbed. But they are sessile, and the fruits are larger and of a different shape, the leaves are thinner and have the venation more marked than those of *E. Woodwardi.*

4. *E. Campaspe,* S. Le M. Moore.

The foliage is much smaller, the buds are nearly sessile, rounded in shape (ovoid), the fruits nearly hemispherical and the valves slightly exsert.

5. *E. pleurocarpa,* Schauer (*E. tetragona,* F.v.M.)

The foliage of this and *E. Woodwardi* are often a good deal similar and so they might be confused in the bush. The branchlets and buds are a good deal more angular, and the calyx is toothed, the fruit is larger and more cylindrical. *E pleurocarpa* belongs to the section Eudesmiæ, and the anthers are different.

6. *E. pruinosa,* Schauer.

It has some general resemblance to the above species in its glaucousness and (sometimes) size of fruit, but the two species differ sharply in anthers and foliage (the leaves of *E. pruinosa* are sessile).

Note added 21st September, 1909. A specimen in flower, in the W.A. Museum, dated 19th August, 1901, collected by Surveyor Anketell, Muir's Continental Railway Survey, is this species.

Eucalyptus Morrisoni, n. sp.

Eucalyptus Morrisoni, n. sp.—A straggling shrub, about 8 feet high. One patch seen 50-150 miles east of Kalgoorlie, Transcontinental Survey. Collected by Henry Deane, M.A., M. Inst., C.E. Consulting Engineer, May, 1909.

Frutex ramis sparsis circiter 2-5 m. altus. Folia glauca, coriacea, conferta, orbiculata, 1-2 cm. diametro, amplexicaula, inconspicue venosa.

Flores conferti in fine ramorum umbellis usque ad 7 in capitulo, brevissime pedicellati. Calyx subconicus, sine angulis, gradatim in pedicello, operculum simile forma magniutdineque.

Filamenta sulphurea, antherea duabus cellis didymis, glandula magna.

Fructus subcylindricus, circiter 6 mm. longus 5 vel 6 mm. latus.

Capsula mersa sub orificio.

Videtur *E. pulvigerae* forsan approximandus.

Juvenile leaves.—No very young leaves collected. Probably there is no difference between the juvenile and mature leaves.

Mature leaves.—Glaucous on both sides, coriaceous, crowded, the branchlets rounded. All nearly orbicular and varying in diameter from about 1 to 2 cm. slightly amplexicaul, apex usually absent or slightly emarginate. Midrib moderately conspicuous for the basal half of its length, lateral veins anastomosing. Incipient crenulations on the margin in some leaves.

Buds and Flowers.—Crowded at the ends of the branchlets in umbels up to 7 in the head. Very shortly pedicellate, the common peduncle short also. Calyx conoid, not angular, tapering gradually into the pedicel; the operculum similar in shape and size, often bent or curved at the top.

Filaments yellow, the anthers with two parallel cells joined together for their whole length, and with a very large gland at the back.

Fruits.—In branchlets forming a compound panicle, the individual fruits sub-cylindrical, about 6 mm. long and 5 or 6 mm. broad, sharply separated from the pedicel. Capsule well sunk below the orifice, valves three or four.

In honour of Dr. Alexander Morrison, formerly Government Botanist of Western Australia, who has done so much to diffuse a knowledge of the vegetation of his State.

E. Morrisoni belongs to the somewhat heterogeneous group (as regards affinities) of species with perfoliate or otherwise strictly opposite (sessile) leaves in the mature stage.

It would appear from *B. Fl. iii,* 187, that Bentham did not attach much importance to shape of sucker or juvenile leaves.

Nevertheless he used these young leaves to some extent for classification purposes, *e.g.*, "Leaves in the young saplings of many species and *perhaps all in some species* (my italics), horizontal, opposite, sessile and cordate" (*B. Fl. iii,* 185).

Some species so included in Bentham's time are now known not to be sessile throughout life, and it is very possible that, as time goes on, it will be found that all Eucalypts are *heteroblastic* (*blastos,* a shoot), *i.e.*, having juvenile leaves different from mature ones. This, if proved, will come about in two ways, by (*a*) the discovery of two kinds of leaves on existing isoblastic species, or (*b*) the discovery of two species (now accounted isoblastic), one with cordate, etc., leaves entirely, and the other with usual falcate, etc., leaves entirely to be conspecific.

We have much to learn in regard to the effect of changed environment on different species of Eucalyptus, and experiments in cultivation have thrown, and will continue to do so, much light upon variation in this direction.

So far as I know, the only species of Eucalyptus (in addition to the present one) which are isoblastic are:—

1. *E. pulvigera*, A. Cunn. A rare New South Wales species.
2. *E. cordata*, Labill. A Tasmanian species.
3. *E. macrocarpa*, Hook. A very coarse Western Australian species.
4. *E. pruinosa*, Schauer. Indigenous to Western Australia, North Australia, North Queensland. (I have seedlings of this species raised from seed collected by Prof. Baldwin Spencer, at Whanalowra [?], Northern Territory, in 1903, which are distinctly pedicellate!)
5. *E. ferruginea*, Schauer. With sessile cordate rusty pubescent leaves—an Angophoroid species from Western Australia and North Australia.

6. *E. setosa*, Schauer. A sessile cordate, Angophoroid species with bristly branchlets, from Queensland and North Australia. Then we have, in a class by itself—

7. *E. perfoliata*, R. Br., with very large perfoliate connate leaves and fruits.

In this case two opposite leaves cohere into a single lamella which is pierced by the stem. From Western Australia.

8. *E. gamophylla*, F. v. M., as figured by Mueller in *Eucalyptographia* shows no stalked leaves, but it becomes eventually lanceolate and very shortly stalked. See a specimen from Central Australia collected by C. Winnecke about 1884 (Herb. Melb.), thus leaving *E. perfoliata* the only connate-leaved species to date.

9. *E. peltata*, Benth., is worthy of special mention. Its leaves are alternate, peltately attached to the petiole above the base, and broadly ovate. This unique species is figured in *Eucalyptographia* and morphologically it is an incipient form of the connate-petiolate leaf.

Therefore our new species presents affinities to—

E. pruinosa, Schauer.
E. pulvigera, A. Cunn.
E. cordata, Labill.
E. macrocarpa, Hook.
E. ferruginea, Schauer.
E. setosa, Schauer.

It differs from all of them in colour of the filaments, from *E. macrocarpa* it is sharply separated in the size and shape of the fruits, from *E. ferruginea* and *E. setosa* in the leaves, fruits, vestiture, etc.

Then there remain *E. pulvigera*, *E. cordata*, *E. pruinosa*.

From *E. pulvigera* it differs in the very much larger leaves of that species, in the shape of the buds, slightly in the anthers (see below), in the fruits in threes ; the fruits are also very much larger, more hemispherical, with a defined rim, and are sessile on a common peduncle.

From *E. cordata* it differs in the foliage (larger even than *E. pulvigera*), in the fruits, which are large and almost hemispherical ; the other characters are those of *E. pulvigera*.

The anthers of *E. pulvigera* and *E. cordata* are identical. They also very strongly resemble those of *E. Morrisoni*, but they appear to differ in having a smaller gland and in being more versatile.

From *E. pruinosa* it differs in the very much larger leaves (usually elliptical or tending to lanceolate), larger and more numerous flowers and fruits. The fruits also have a well defined rim, and, like the branchlets and pedicels, are more or less angular.

The two species are sharply different in the anthers, which in the case of *E. pruinosa* belong to a section with a small gland at the top and small openings of anthers.

The Adaptation of Plants to Environment.

By A. MORRISON, L.R.C.P. & S. (Edin.)

(Read before the Society on the 14th September, 1909.)

As the land composing the State of Western Australia has been for many ages undisturbed by upheavals of a geological nature, the soil and climate must have varied very little during all that time, so that at the present day the conditions of existence for organic beings may be taken to be similar to those prevailing many thousand years ago. Through all this time successive generations of plants have been accommodating themselves to the conditions surrounding them, with the alternative that, if they could not so adapt themselves, they would suffer extinction. Individual plants that have for any reason been able to withstand particular trying conditions better than their companions have in consequence of this survived, and their descendants, through their possession of those qualities, have continued on their course. A certain amount of modification of structure will accompany, if it be not the cause of, this power of resistance, and when further modifications of the same kind arise, or others equally favorable, or other characteristics are introduced by crossing with different forms, the plant may thus, by a process of natural selection, be so much altered from its original form as to constitute a distinct species. Long continued drought, for example, would impose such a test of the endurance of plants; and as a matter of fact, drought, periodic or constant, is the most prominent and characteristic feature of the environment of plants in Western Australia. In only a few other regions on the earth's surface is aridity of climate so pronounced as in some parts of Australia, and yet the driest parts of its area are furnished with plants able to live through it and propagate their kind. We are thus led to infer that our native plants must be particularly well adapted to droughty conditions, while the duration of this dry environment and of the resulting structural modifications, seems to suggest the idea of fixity of the forms now existing, seeing that a long-continued succession of similar seasonal cycles, with little disturbance of soil conditions, must in the course of time have brought each form of plant to a state of perfection in its adaptation to this unvarying environment.

According to Weismann and others, acquired characters cannot be inherited, the germ plasm being continued unaltered in structure from parent to offspring, and therefore incapable of producing new characters; so that no matter how highly any particular characteristic may be developed during the lifetime of an individual organism, that characteristic cannot possibly be inherited by the offspring, at birth that is to say. Hence they deny the correctness of part of the theory of development propounded by Darwin, who believed that the inheritance of acquired characters was one of the means through which new species arose, besides the crossing of one species or variety with another. All depends, however, on the sense in which the characters called "acquired" have arisen. If acquired characters were heritable in the sense that the progeny at birth would be provided with them, then an animal or a plant at various stages of its course through life ought to produce descendants showing characteristics corresponding to those acquired by the parents at particular stages. Although the traits evolved in an organ or tissue by the action of particular stimuli brought to bear on them in their environment may not appear in the progeny at their birth, there is at least no reason to suppose that the descendants should be less capable of developing the same characteristics in a similar way. On the contrary, each successive generation subjected to the same conditions—to the same stimuli or the same absence of stimuli—may carry the development of a characteristic further and further to an indefinite degree, and the capacity for such specialisation may become greater and greater the longer the favouring conditions keep the same. We can scarcely impose a limit to the degree to which an organ may develop under special stimuli, or to the successive forms an organ may pass through in a long series of generations, all under the action of the vital forces inherent in the germ cells. If an entirely new organ or a structure of a different type were supposed to be included in the expression "acquired character," it would be quite reasonable to doubt the possibility of such being produced in the individual or inherited by the descendants. But if the specialisation has taken place simply from the action of the stimuli encountered in the environment on the qualities inherent in the germ cells of the organism, it seems quite reasonable to expect that not only the capacity but the structure evolved on typical lines may in time become fixed and heritable; and when by the action of the external forces (such as drought) educing these new traits those organisms lacking them are cut off on account of unfitness, the characters of those surviving may be very unlike the originals. Apart from the direct inheritance of acquired characteristics, however, a highly developed trait may have an important influence on the capacity or chances of an individual plant or animal so provided for effective crossing with another variety.

The structural modifications by means of which plants are enabled to live and flourish in dry climates are very varied and interesting. In some cases the plant as a whole, or particular organs, are highly specialised to cope successfully with drought, while the great majority of our species show some indication in their structure of the necessity that exists for special provision against this feature of the climate. In considering the question of how this is effected it is necessary to study the relation of the plant to water, the element of most vital importance to it. Plants live and grow by the absorption of water from the ground by means of their roots, which serve also to keep them in a fixed position. This water finds its way through the stem and branches to the leaves, from the surface of which it is exhaled into the air. It is not always pure when it enters the plant, but contains, dissolved in it in small quantities, a number of different mineral substances necessary in the formation of its tissues. Sometimes, however, these ingredients in the water are prejudicial to the growth of the plant, and may cause its death; in other cases they may be tolerated or even favorable to growth, while in others again they may be the cause of peculiarities of structure sufficiently pronounced to have caused botanists to describe as distinct species, plants so modified by the absorption of water charged with a particular mineral substance derived from the soil in which they grew. These substances in the soil may be injurious to the majority of other plants, so that toleration of them by a particular variety may be the means of its advancement and spread, through being relieved from the competition of other plants in that soil.

The great bulk of the woody tissues of the plants, however, is not derived from the water supplied through the roots, but from the atmosphere, which contains carbonic acid gas, the source of the element carbon, the chief constituent of wood. The extraction of carbon is effected by the vital action of the leaves in their performance of the function of respiration. In a large tree bearing many thousands of leaves it can be understood that a very great quantity of water is required for its growth, but if the soil does not contain much or soon becomes exhausted the growth will be proportionately restricted. In soils that are very dry or liable to become so at particular seasons plants must be modified in some such way as will enable them to do with a scanty supply of water. One obvious way in which moisture may be secured, even during the dry season, is by an extension of the root system to the deeper strata of the soil, which are less subject to the desiccating influence of the sun and atmosphere than the superficial layers. As we have a very long dry summer we should expect to find the great majority of our native perennial plants to have roots long enough to reach deep into the ground. Examples of this may be found by anyone who will take the trouble to dig deep enough. As an example, let me mention *Calythrix flavescens*, a small shrub less than a foot high, that makes the sandy scrub gay with its bright yellow flowers during the hottest months of summer, when the majority of flowers have faded. It will be found that the clusters of branches appearing above ground spring from a root-like underground stem running horizontally at 3 to 6 in. below the surface, and that the true roots for absorbing moisture are attached to this and extend downwards to a lower stratum of the soil. In like manner the bush casuarina (*C. distyla*) of the sandy scrub sends out underground shoots which at intervals come to the surface as young plants, thus helping in its propagation independently of its seeds. The same thing occurs more strikingly still in the Christmas tree (*Nuytsia floribunda*). When this tree becomes broken down, as easily happens on account of the brittleness of its wood, or succumbs to a bush fire, it frequently occurs that within a radius of a few yards from the old tree a large number of young bushes have made their appearance, sometimes in a circle, and these are found attached to underground shoots given off by the old stock at various depths below the surface of the ground.

These plants illustrate one arrangement by which the drought of a long dry summer, and other untoward conditions may be overcome; but there are many other ways in which the root system is modified in a special way to retain life in the plant, and even at shallow depths in the soil. Such are seen in bulbs, tubers, and various forms of swollen roots or underground stems, in all of which water is stored up during the wet season of the year, that the germ of the plant may be kept alive through the droughty period, to start into active growth again when the next rains supply moisture sufficient for the growth of a new plant which forms roots and provides a new bulb or succulent organ in which water is again stored up. It is not solely in the underground portions of plants that this storage of water is effected; we see it also in the stems and branches of plants such as those of the *Cactaceae* and some *Euphorbiaceae*, giving them quite a peculiar character. This type of plant is seen in the most arid regions, where only a scanty rainfall over a short period of the year must be made the most of for growth and storage, before the hot, dry air takes it all back from the ground. Active transpiration is not possible in these dry surroundings, and as leaves are not required to carry off surplus water they are suppressed altogether or reduced to scales or prickles, the stems themselves taking their place and performing their functions to the extent required. In these plants, and in succulent plants generally, water is stored up in cellular tissue set apart for the purpose, to be drawn upon when necessary. There are many native plants around us with succulent leaves in which water is stored against drought, such as the saltbushes, mesembryanthemums (or "pig-face"), members of the Portulaca family, including the ice-plant, in which water-containing cells on the surface of the leaves glisten like particles of ice. Some of the lobelias poisonous plants not uncommon with us—frequently have their juices so carefully stored and protected from evaporation in stem and flower that we may find plants still standing upright in the ground, flowering and ripening their seed, although the root and lower part of the stem with the leaves on it are dead and brittle. Others, of the portulaca family, are so retentive of life that they may be used for room decoration without water for weeks or months, while under heavy pressure within sheets of drying paper they continue their growth for long periods.

As the leaf is the respiratory organ of the plant, besides being concerned in transpiration, its formation and intimate structure are important objects of study. The leaves are in direct continuity with the roots through the medium of the vascular fibres, which pass from the roots through stem and branches, and from these through the stalk of the leaf, breaking up on entering its blade into an expanded network visible to the naked eye, so that every minute portion of its area is supplied with water. The surface of the leaf is studded over with minute pores, which allow the water to escape into the air as vapor, and at the same time let in the air for respiratory purposes. The small cavities to which the pores or stomata give access are lined with delicate living cells which are the active agents in the function of respiration or breathing. The carbonic acid gas entering with the air becomes dissolved in the water that has ascended from the roots, and is thus presented to the active living cells which decompose it into the oxygen which escapes into the atmosphere, and the carbon which is appropriated for the formation of the woody tissue of the plant. The breathing pores or stomata ar so affected by the state of the atmosphere that when it is very dry the two cells guarding them so alter their form and position as to close the opening, while with a moist atmosphere and a full current of sap flowing they become more turgid and bulge outwards so as to form an opening that allows communication with the air again. It can be well understood that in a dry climate a large distilling apparatus of the kind indicated would not generally be suitable; for lack of moisture it could not be kept in action. The extensive scale on which broad-leaved trees in a moist atmosphere transfer water raised from the ground to the air has to be reduced, so that the quantity exhaled shall be proportioned to the amount present in the soil. Accordingly the broad leaves, with innumerable breathing pores, must have their surface diminished in extent, and the cellular tissue and stomata reduced in proportion. In conformity with this requirement we find that in a very large number of our local plants the foliage is of a very stiff, spiny, and harsh character, the soft cellular tissues being reduced to a minimum, the leaves being narrow, with prominent ribs, and ending in sharp points.

As we have a copious rainfall in the winter months, a luxuriant growth of some broad-leaved plants is encouraged, but the leaves of such, not being deciduous, are protected by many interesting devices from the influence of the dry air and hot sunshine of summer, which directly tend to induce transpiration and rob the plants of their moisture. The leaves of the eucalypti, acacias, and others are set in a vertical position, so that their surfaces will be parallel to the sun's rays at the hottest time of the day, and so receive less heat. In others the leaves are covered with hairs, especially on the under surface, and sometimes they, or the whole plant, are enveloped in a covering of hairs so dense and so matted together as to resemble thick flannel or blanket. Such a covering not only protects the substance of the leaf from excessive heat or cold or other injurious influences, but it may retain for a considerable time such moisture as may come to it from rain or dew, to the benefit of the plant. During the growing season leaves may be somewhat soft and delicate, but with a gradually increasing intensity of sunshine and dryness of the air, the superficial layer of cells forming its substance may become thickened into an impervious cuticle, preventing evaporation of the moisture below, and modifying the effects of the light and heat of the sun. In other cases fluids are excreted on the surface of the leaf, so that the epidermis is protected and the stomata effectually sealed with wax, gum, resin, or lime. In some leaves the stomata are so deeply sunk below the surface as to be removed from the direct action of the light and heated air, or they may be situated in the bottom of grooves which themselves become shrunk and partly closed when the air is dry. In some grasses and sedges you may observe that as they grow the leaves are quite flat, but shortly after the stalk is plucked you find that the leaves have lost their flat character and appear curled up lengthwise, the change being due to the stoppage of the sap current when the stem was severed from the roots. One of the plants which come into flower about Perth in spring is *Grevillea oxystigma*, a small shrub with abundance of white blossom. As long as the rainy season lasts the leaves are mostly flat, but at a later date, in the dry season, they appear more often as double-barrelled tubes, each half of the blade having curved backwards to the midrib, as if to exclude the dry air from the under surface, which is already protected by a covering of minute hairs. This rolled condition appears to be more constant in the drier districts of the interior, such as Kellerberrin or the Stirling Ranges, while in these localities other species of *Grevillea* show the peculiarity in a still more pronounced degree. The rolling back of the margins is often so tightly effected in some plants that the leaf must be broken up in order to see the hidden under-surface. From this condition of the leaf it is only a step further to one that is quite solid with the under-surface obliterated and a groove marking the position of the midrib; and from that again we easily arrive at the terete form, as it is called, like a knitting needle, quite smooth all round, presenting to the air the least possible area of surface, and ending most frequently in a sharp point.

It is interesting to note how the stems of trees and other plants are protected from injurious external influences. In a visit to the North-West I was struck with the fact that the few trees seen had their trunks and branches provided either with a rough, thick corky bark or had them smooth and quite white as if painted with a cooling composition such as that applied to the roofs of houses. In either case it evidently serves as a protection from the excessive sunshine and heat of the region. The heat of the sun and air is probably the cause of the development of the thick protective cuticle, like that on the palm of the village blacksmith, and the white stems reflect the light and heat of the sun, so that the interior of the stems will not suffer injury.

When the moisture in the soil is not pure water, but contains particular substances dissolved in it, such as salt, many plants would be killed or injured if planted there, while others, like saltbushes, would grow and thrive. The saltbushes may grow well in an ordinary soil, so that a distinctly brackish condition is not indispensable to them ; but they have a tolerance or affinity for salt, and may extract more of it from an ordinary soil than other plants do, and store it up in their tissues. They thrive better in a moderate degree of brackishness, however, and their roots, when not in active growth, might suffer no injury from a somewhat concentrated solution, of salt, as those of other plants would.

The subject of the adaptation of plants to their surroundings may be said to be co-extensive with the Vegetable Kingdom, and we may go on speaking of examples of their ways and means of doing so indefinitely ; but it would be advantageous to consider some of the means by which the economically important family of Grasses maintain their position under trying conditions. In some grasses—for example, *Sesleria tenuifolia*, a South European species—a remarkable intricately-woven tunic is provided for the covering and protection of the lower parts of the stalks. The sheaths of the lower leaves—the part of the leaf embracing the stem—are composed of longitudinal and crossing zigzag fibres so woven together as to form an intricate network in the tissue of that part of the leaf. When the upper part of the leaf withers and drops away in dry weather this fibrous net remains as a protective clothing for the stem of the grass during the trying period between summer and the following spring. Instead of having a woven fibrous tunic the base of the leaf sheath may be more straw-like in its nature, as in some of our native grasses : in drought, however, either texture is calculated to protect the plant, to absorb moisture when the chance occurs, and to retain it for a longer or shorter time during intermediate dry periods.

In Australia and South Africa another form of protective covering has been evolved in the native grasses of those parts of the world. On the bases of the leaf sheaths, instead of woven fibre or straw as described, we find a great development of hairs of a woolly nature so copious as to completely cover the base of the stem and give it a bulbous appearance. These woolly hairs are sometimes woven into a feltlike fabric of appreciable thickness, giving effective protection from injurious outside influences, and at the same time preventing the escape of moisture, while it absorbs water from the atmosphere and retains it for the replenishment of that required in the vital processes carried on in the living tissues of the plant. *Eragrostis eriopoda*, a North-West grass, gives a typical example of this arrangement, which may also be observed, though to a less degree, in other species of *Eragrostis*, *Stipa*, *Panicum*, *Danthonia*, etc. It would be easy to demonstrate the power of this felted tunic to retain moisture by wetting a clump of one of these grasses and a similar clump of another grass unprovided with a hairy covering, and laying both in an open place to dry, when it would be found that the felted covering would still be moist long after the other had become perfectly dry.

In the sandy soil about Perth and in the South-West generally during the spring months may be seen a tall purplish grass, bearing at the top of its stalk a loose bunch of flowers somewhat resembling quaking-grass in shape. This is *Poa nodosa*, which grows up during the wet season, and continues for some time further into the dry period, flowering and ripening its seeds when the sand in which it grows is almost constantly dry. If the base of the stem is examined, there will be seen one, two or three bulbous swellings of the base of the stalk, just below the surface of the sandy soil. These swellings are succulent, and contain a store of water in anticipation of the plant's needs during the course of the long periods of dry weather that are sure to follow. A similar formation is found in a variety of the well-known Timothy grass that grows in the drier districts about the Mediterranean Sea. There is no specific difference between this variety and the typical form (*Phleum pratense*) found in moister localities, beyond the presence of the bulbous swelling of the underground stem ; and when this form is transplanted to cultivated ground and supplied with sufficient moisture, the stems lose their bulbous character. Whether Timothy grass grown in dry localities in Western Australia ever assumes this bulbous form, perhaps some of our agriculturists may be able to say. If it should be able to adapt itself to our climate it may be worth encouraging for that reason alone ; but whether the bulbous form be imported as such from its native steppes or modified from the ordinary form by a process of acclimatisation, it would be scarcely reasonable to expect it to possess the same succulence as the grass grown with abundant moisture. It might prove of value in dry districts, but at the same time our native grasses, long used to the climate, may be found, if properly tested by experiment and analysis, to be quite as nutritious.

Under a sort of fatuity we neglect the plants growing in our own soils and search all over the world for new kinds of fodder plants, without giving a thought to those growing in our near vicinity. There are many native grasses and saltbushes adapted to withstand the most severe droughts, and all that is done is to take advantage of the bounty of Nature and use up all the herbage provided till it is in danger of extermination. The grasses are known to be highly nutritious, but no steps are taken to preserve them or to extend the area of their growth; while the saltbushes, though they have been analysed and proved in foreign countries to have high feeding qualities, receive scarcely any consideration. In connection with this subject we have to distinguish between perennial plants and annuals. The pastoralists are concerned with the former, but their scheme of development of the country grazed upon does not often include provision for the future continuance of the fodder plants originally provided. On the other hand the cultivator of the soil imports plants from foreign countries, apparently without always considering whether the conditions of existence here are fairly comparable with those of their home country. Fodder plants from India, with its combination of heat and moisture, may grow here, but they could not be expected to do as well in our dry season as in their own home. Some plants from that country or from the basin of the Nile might produce abundance of fodder or fruit, with the help of irrigation; but land is so plentiful and the population is so scanty in Western Australia that irrigation does not recommend itself to cultivators.

APPENDIX.

Notes on Plants specially mentioned, with Plates II. to V.

Plagianthus Helmsii, F. v. M. and T.

Natural Order, MALVACEAE. The "dunna-dunna" of the aboriginals, first found at Lake Lefroy by the Naturalist of the Elder Expedition, whose name it bears, and also later at Nannine. Though to the naked eye appearing bare, the few stout branches are completely covered with small rosettes of minute leaves, in the centre of which is seated the tiny flower. (Plate II, Fig. 1.)

Eragrostis eriopoda, Benth.

A grass confined to the North-West Division of Western Australia. The base of the stem and lower leaves is covered with a felted mass of woolly hairs affording an effective protection against the heat and drought of the climate. (Plate II. Fig. 2.)

Brachysema daviesioides, Benth.

A leafless, spiny, low shrub of the Natural Order, LEGUMINOSAE, from Coolgardie, hitherto recorded only once as having been found by James Drummond many years ago. From a short stem arise a number of branches which are repeatedly forked so as to form a dense thicket of thin but rigid branchlets ending in spiny points. The leaves are represented by very small scales, not visible to the naked eye, and the red flowers, each about one inch in length, are clustered round the lower part of the stem, where they are protected from injury, though small birds are able to reach up to them to suck their honey. (Plate III. Fig. 1.)

Calandrinia primuliflora, Diels.

One of the Natural Order, PORTULACACEAE. The specimens from which this illustration was taken were found at Carnamah in gritty soil on the edge of an outcrop of granite, and in cracks and shallow places where pieces of the rock had split off. The tuberous root is not a true bulb, but a store of water, and probably of nutritive material, without which it could not live in such a situation. One of the tubers is seen to be bent at a right angle, showing that at a depth of about an inch its growth downwards had been checked by the rock and changed into a horizontal direction. The plant shows a wonderful capacity for enduring the intense heat of granite exposed to the sun in early summer. (Plate III., Fig. 2.)

Lachnostachys verbascifolia, F. v. M.

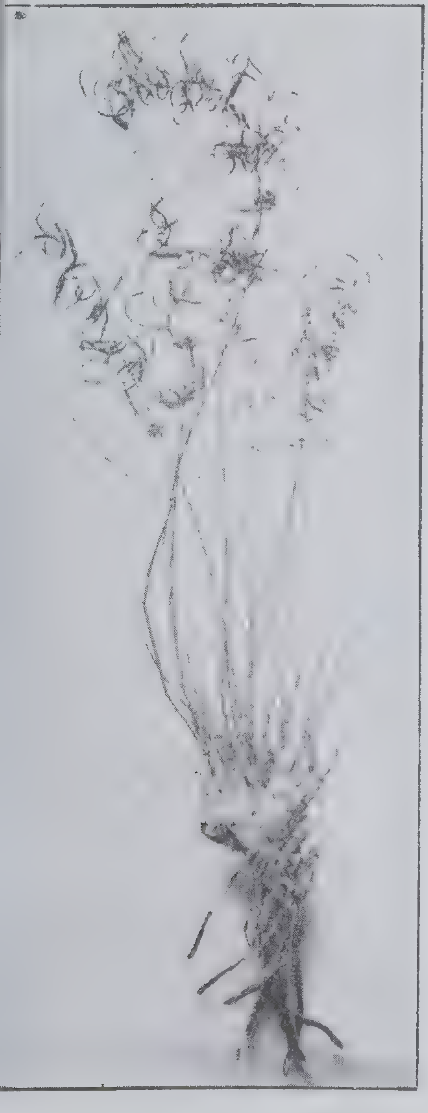
Natural Order, VERBENACEAE. This plant, first found by Drummond, was brought from Yalgoo, Murchison district, and, like many others in the same family, shows a remarkable development of the hairy covering. With the exception of the inner parts of the flower, the whole plant is covered with a thick soft blanket-like clothing, composed of innumerable branching hairs. (Plate IV Fig. 1.)

Daviesia euphorbioides, Benth.

This plant is usually set down as a Cactus by those who have seen it growing, from its likeness to the leafless Cacti of the hot and dry regions of America, of which country alone they are true natives. The specific name has been given on account of its resemblance to some forms of EUPHORBIACEAE, which are also leafless. Its true nature is disclosed by the presence of a triangular pod attached to the stem, showing it to be a leguminous plant and one of the genus Daviesia, which is represented in Western Australia by many species, with or without leaves. While in *Plagianthus Helmsii* there are innumerable small leaves covering the thick stems, in this plant they are represented by

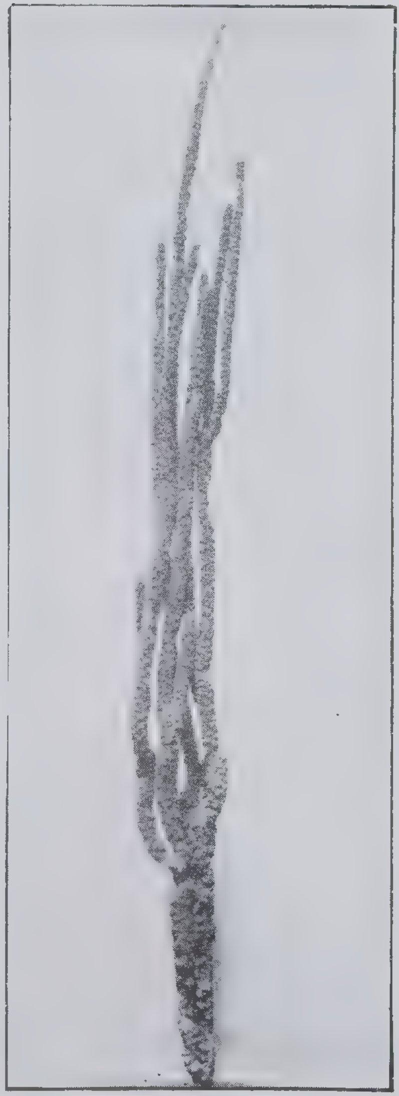
VOL. III. PLATE II.

FIG. 1.



Plagianthus Helmsii.

FIG. 2.



Eragrostis eriopoda.

ERRATA.

The block on the right to read: FIG. 1—*Plagianthus*, and the block on left to read: FIG. 2—*Eragrostis*.

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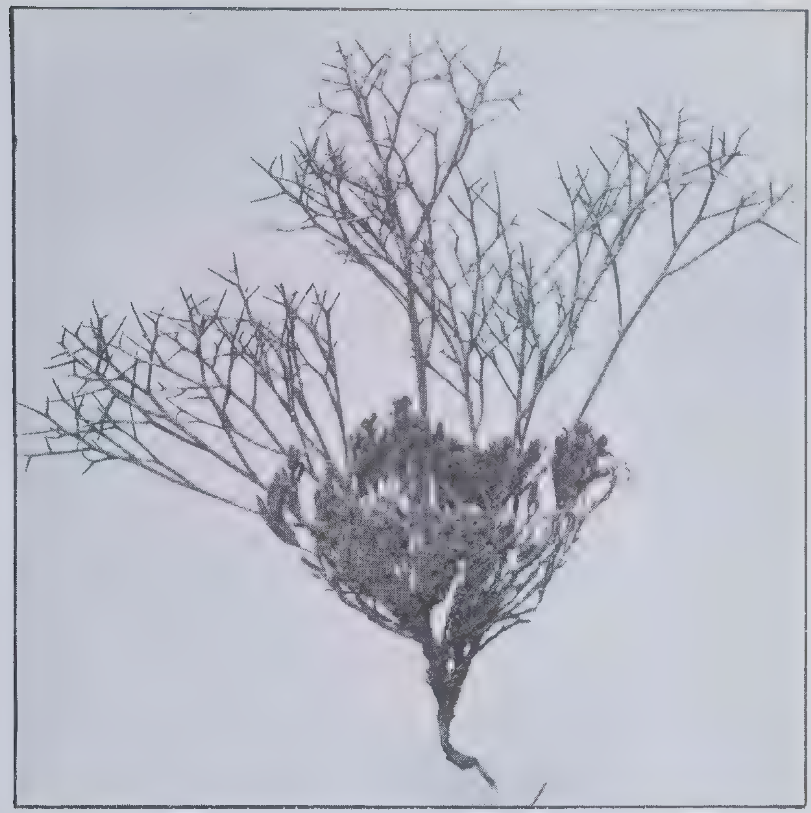
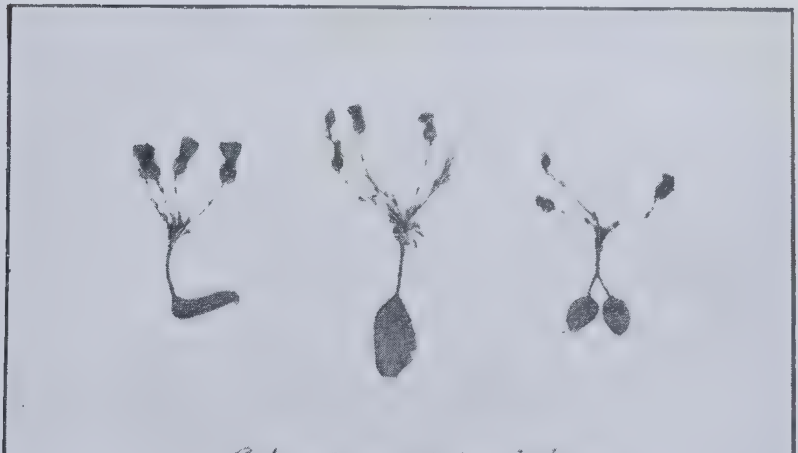
VOL. III. PLATE III.

FIG. 1.



Brachysema daviesioides.

FIG. 2.



Calandrinia primuliflora

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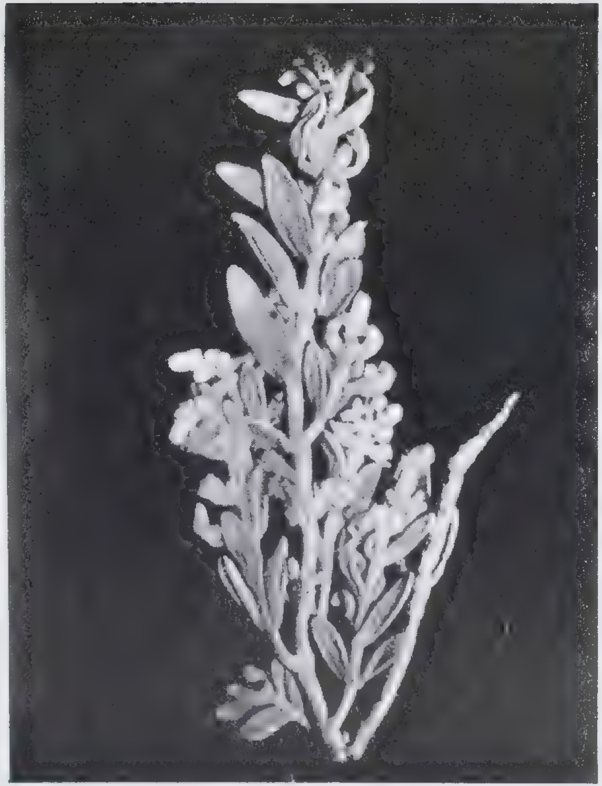
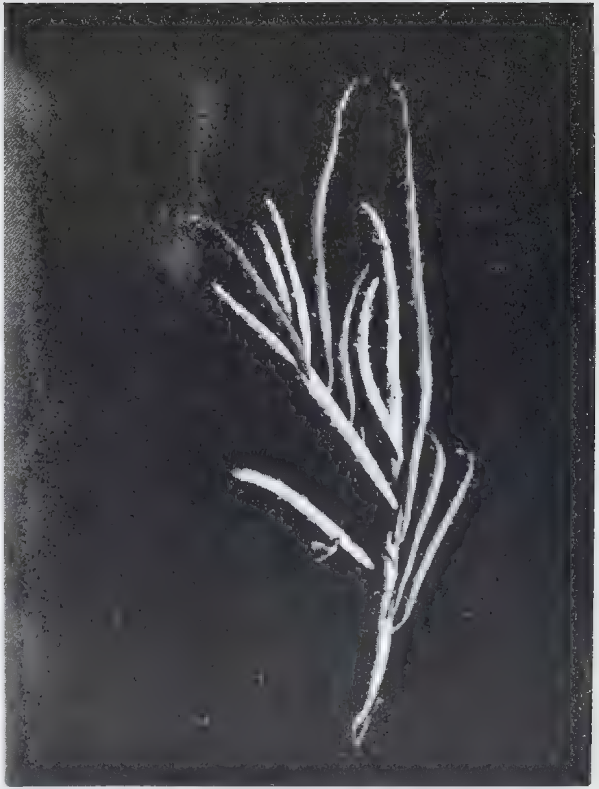
Fig. 1.

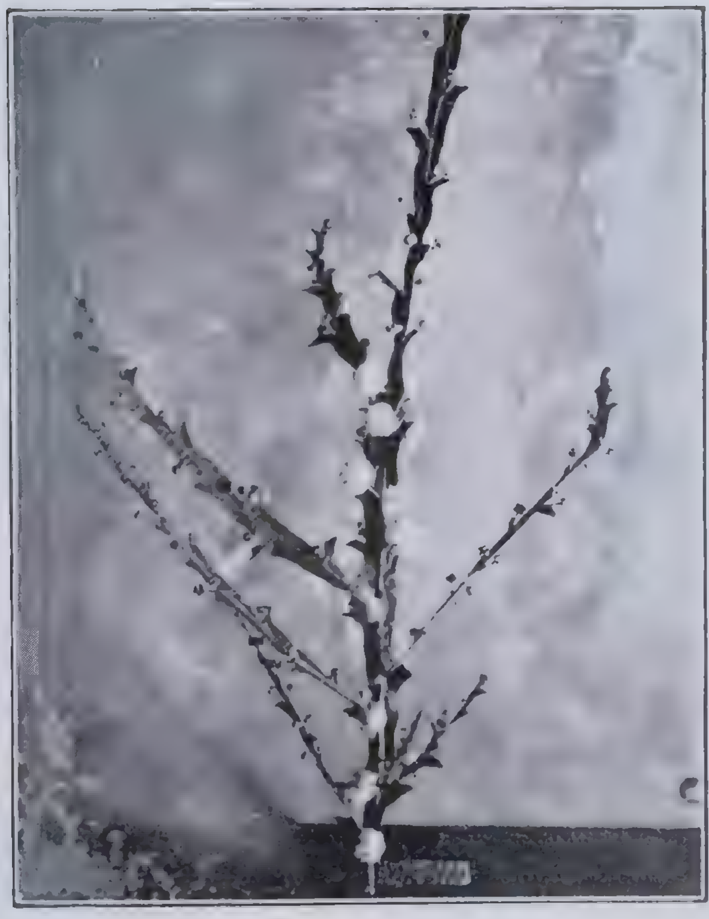


Lachnostachys verbascifolia.

Fig. 2.



Daviesia euphorbioides.



Acacia alata.

NATIONAL MUSEUM MELBOURNE

minute hooked thorns scattered over the surface of the branches, which themselves are green and adapted to perform the function of leaves. The woody fibres of the stem spread out to form a thin layer under the cuticle, and inside this rigid tissue a wide space is occupied by a spongy pith, adapted to hold moisture. (Plate IV. Fig. 2.)

Acacia, alata R. Br.

A Leguminous shrub of the Sub-Order MIMOSEAE. Along with four others, it forms the Series Alatae of the genus Acacia, which are peculiar to Western Australia. Not only are the leaves in this Series reduced to phyllodia, but these enter into the formation of the stem and branches, providing them with wings, and having only their tips free. (Plate V.)

The Flower Biology of Marianthus Lineatus.

By OSWALD H. SARGENT.

(Read before the Society 25th May, 1909)

Marianthus lineatus, *F. v. M.*, is a member of the Natural Order *Pittosoporaceae.* I have found it in several places about York, on ironstone land, under the shelter of "White Gum" trees (Eucalyptus redunca chiefly). It varies between a stiff shrub growing independently of support, and a twiner twisting its wiry stem round young trees, in one instance to the height of ten feet, but usually much less. The usual form is a shrub of about three feet, with many of its branches twining together at the top.

It blooms profusely—the leaves being almost hidden by the multitude of flowers—from January to April. The flowering plant, however, is inconspicuous, except when seen against a dark background, as the general color effect of the blossoms is a warm grey, which differs but little from the tone of the surrounding vegetation at this time of year. A vigorous plant continues in flower for fully three months. The inflorescence is a sort of mixed panicle. The terminal flower of the whole first unfolds, then the terminal flowers of the branches, commencing with the lowermost. In this district the panicle is usually reduced to three flowers, a terminal and two laterals, and these three follow the cymose-racemose order of anthesis. My time has been fully occupied in studying the flower, so I have not yet given the inflorescence the attention it deserves.

The individual blossom is remarkably elegant. The calyx is an inconspicuous whorl of tiny triangular sepals; beauty resides, as usual, in the corolla. This is about an inch across, and consists of five petals resembling notes of exclamation (!) in shape. Their bases are erect, interlocked, but not connate, and occupy a complete circle round the essential organs. A little above the base all bend outwards and diverge apart. The lateral and anterior petals are also bent sideways, so that the upper part of the corolla occupies a half circle only. The apices of all the petals are gracefully recurved. These recurved tips are creamy white. Below on a cream ground mottled with purple each petal bears five longitudinal stripes of a rich warm purple hue. So fashioned and painted the corolla may well be described as a fairy bonnet fit for Titania herself.

The flower is borne on a slender erect stalk, which curves abruptly a little below the calyx. Thus the axis becomes horizontal and the corolla forms a protecting hood over the stamens and pistil.

The five stamens though not united are fairly closely packed round the pistil. They are of three lengths: the two dorsals are shortest, the anterior one longest, and the two laterals intermediate in length. All are curved towards the corolla. The anthers are attached by mere points to the acute apices of the stamens, so they can swing freely in all directions. The anther of the longest stamen is introrse, those of the shortest extrorse, and those of the intermediates, on account of torsion of the filament, are transverse. Thus all the anthers face the corolla. Their adjacent edges are in contact, so that together they form a compact oblong cushion, which stands a little distance in front of the central petal.

The flower opens soon after sunrise, and the anthers dehisce an hour or so later. The pistil, a simple awl-shaped structure, is now hidden by the stamens. Its style is straight and its stigma unripe. This is the first stage of flowering. The second stage is reached about four days after opening. The anthers have now lost their pollen, the stamens fall apart and bend down, the style is curved towards the corolla, and the small apical stigma (now ripe) occupies the place vacated by the anthers.

I first saw the plant in flower about ten years ago, and it was a case of "love at first sight"; but it was not till February, 1906, that I began to seriously study the flower. Since then it has received the "lion's share" of my attention during the early months of each year. I have on numerous occasions seen Insects of various kinds visiting the flowers. The most frequent visitor is a small "Native Bee," golden-brown in color and much resembling an ant in appearance. This creature (*Exoneura pictifrons* by name) usually only collects pollen, but I have on several occasions seen it crawl into the flower in search of nectar. When pollen collecting it naturally only visits first stage flowers, and when seeking nectar it does not come in contact with anthers or stigma, because it is too short. Thus it is useless as a pollinator. It is an "unbidden guest"—a robber.

The next most frequent visitor is apparently a close relative of the common House fly, which it much resembles in appearance and size. The most noticeable points of difference are—the back of its thorax is more thickly coated with rather long stiff hairs, and when at rest it folds one wing completely over the other. This curious habit gives the insect quite the look of a beetle at first sight. This creature, whose name I have not yet ascertained, is, I believe, the chief pollinator of the Marianthus flower, at least in this district (York). I think so because there seems a connection between the frequency of its visits and the quantity of fruit produced. • A species of gnat or mosquito is a fairly frequent visitor. It also is a very efficient pollinator. Many other insects, including at rare intervals hive bees, occasionally visit the flowers, and several of them assist in the work of pollination. Their names are unknown to me, and this brief notice must suffice them.

The chief pollinator is usually found crawling about the branches of the shrub. From time to time it crawls over the back of a corolla, and down the middle petal to its base. I have seen hundreds of visits, yet only once have I seen a fly crawl down a side petal. Very occasionally the flies suck the bases of the stamens from the lower side without entering the flower. This fly is just the right size to brush against the cushion of the anthers as it descends the petal. It always collects a quantity of pollen on its back, when it visits a first stage flower. The hairiness of the fly's back would doubtless ensure sufficient pollen adhering, but the pollen itself is sticky and adheres well to the smooth back of a brilliantly iridescent fly, which occasionally visits the flowers. The flies visit first and second stage flowers indifferently just as it happens. When a second stage flower is visited the fly's back brushes against the stigma, which receives and retains pollen, if the fly has previously visited a first stage blossom.

As the anthers and stigma of the flower ripen at different times, automagy is obviously impossible. The order of opening does much to secure that flowers distant from one another on the shrub shall be crossed. The flies often visit in quick succession several flowers standing close together, but these are usually all in the same stage, and even if they are not, only by a long chain of coincidences could a stigma receive pollen from a near flower without also receiving some from a distant one. Take for instance the reduced panicle of three flowers. These are, of course, very closely related. The central flower will probably have fallen before the lower lateral opens, so that crossing between these is unlikely. The third flower opens a day or two days after the second, so that pollen might conceivably be carried from it to the second. In order that this may happen a fly free from pollen must visit No. 3, and then before visiting another pollen-bearing flower resort to No. 2, on the day that No. 2 reaches the second stage, before that blossom has been visited by any other polliniferous insect. This makes close cross-pollination highly improbable. Several times I have seen a fly leave a bush and fly in the direction of one several yards distant ; so crossing between flowers on different plants occurs sometimes, and perhaps often. I do not know whether foreign pollen is prepotent, but I suppose it is likely to be so.

The pollen is cream colored. The grains are tiny—about 37 microns in length and 25 in breadth. In shape they much resemble wheat grains at first sight, even to the median furrow, but an end view—rarely obtained—shows the grain to be cylindrical, with three longitudinal furrows or folds. Just occasionally two of these furrows may be seen as the grain lies on its side The surface of the grain is delicately reticulated. If pollen from an early flower of a well nourished plant be examined, numerous slender glistening viscin threads will be seen connecting the grains together. In pollen from late flowers or ill nourished plants threads are few or wanting, but the grains still stick together in groups. I take it that in these cases the viscin (or the cells providing it) is absorbed more completely as nourishment by the grains, and only sufficient remains to render them just sticky. Late pollen is more dust-like than early pollen, and the anthers of late flowers empty more quickly than those of early ones. Thus it seems at first sight that early flowers have the best chance of pollination, but the numerousness of late flowers tends to counterbalance the dryness of their pollen. So far as I can judge any given flower on the panicle has as good a chance of pollination as any other in the presence of suitable Insects. I have for the past three years kept a number of bushes under observation right through the flowering season, visiting them once or twice per week. When I have found flies plentiful on a shrub throughout the season, flowers on all parts of the panicle produce fruits with apparently equal freedom. I have not found time to make an exact census, but I feel satisfied that, if early flowers have any advantage, it is only a small one. Always those shrubs on which I have not seen pollinators produce few or no fruits. Sometimes mid-season and sometimes late flowers only produce fruits. The inference is that the shrubs were visited by flies only at these times. No specially watched shrubs have behaved so.

Now what induces the flies to visit the Marianthus blossoms? The flowers are not conspicuous from a little distance to human eyes, nevertheless I think appearance plays some part in attracting, because I have noticed that the most conspicuous of a group of shrubs is most freely visited by flies. Early in February, 1907, I placed some flowers in a vase of water in a cool cellar in order to keep them fresh. When I went to them next day I noticed a delightful though faint limonaceous odour, evidently emanating from the flowers. Up to this time I had regarded the blossom as odourless, for I had never been able to detect the least scent, though I had repeatedly smelled flowers carefully, before and after gathering them. I have several times since noticed the odour on perfectly calm days, when standing close to a shrub in the bush, without deliberately smelling the flowers. The perfume much resembles that of Pittosporum and is always developed when flowers are kept in a cool place free from draughts. The least breath of air disperses it. It seems to be particularly pleasing to house flies. If a branch of bloom with the scent well developed be taken into a room the flies fly to it from all quarters. I left a panicle dried in sand with the shape and color of the flowers perfectly preserved, on a table for several days; but the flies completely ignored it.

Now, while color and perfume may attract the flies from afar, surely something more substantial is required to retain them on the shrub, and induce them to visit flower after flower, day after day. Moreover, I have definite evidence that they do obtain some nourishment from the flowers. I have repeatedly caught and imprisoned a pollinator in a bottle. If a Marianthus blossom was enclosed with the fly, the latter lived for several days, indeed until killed; but if shut up without anything it always died within twenty-four hours. Of course, plenty of air was supplied in all cases.

Each petal is slightly saccate at the base, and just above its sides are directed inwards, making the cross-section U-shaped. The trough thus formed is pressed close against the stamens, so that a small tube is completed by the stamens closing up the front. We have, therefore, five apparently ideal nectaries at the base of the flower; but I have often sought nectar therein and *always failed* to find it. Yet it is into these empty nectaries that the flies thrust their probosces. Thinking that possibly the nectar dried or crystallised on the walls of the nectary as fast as secreted (this happens in some plants I have examined), I carefully washed out the nectaries of a number of flowers with distilled water and tested with Fehling Solution. I tried this experiment several times, but the result was always negative. The microscopic appearance of a section of the nectary is not that of secretory tissue, and I have never observed crystals or dried secretion when examining sections. Each epidermal cell of the inside of the base of the petal is produced into a small papilla, more or less bulbous at the top. The cuticle is thickened in ridges, and these ridges continue over the papillae in a slightly spiral manner. I have frequently seen within the papillae tiny drops of oil, which is doubtless the flower's scent. The petal sap is rich in glucose as shown by its reduction of Fehling Solution. There are two ways in which flies might obtain this sweet sap—by breaking the papillae or by squeezing it through them. I have rejected the idea again and again and sought some other solution, but now I feel convinced that the latter is the method adopted. I think the papillae are too strong to be broken by the flies. If, however, they were broken, surely broken ones would be seen in microscopic examination! I have examined a great number of sections, but I have never found a broken papilla. If the broken papillae retained their virgin shapes sap would surely ooze out through the split cell-walls and form nectar in the nectary. A flower is visited not only once, but many times, and, if breaking were the rule fresh cells would probably be broken each visit, and broken ones would not mend. This would surely mean a copious flow of nectar, and a quick withering of the flower, but neither of these takes place. (A flower lasts about ten days, if not previously fertilised ; it must last at least four to reach the second stage.) The inference is that the papillae are not broken. If flowers be left for several hours in a moist chamber a clear colorless liquid rich in glucose appears in the nectaries of many. This is doubtless due to the fact that under such conditions—a warm, moist atmosphere—osmosis is not checked, while transpiration is, so, the cells becoming hyperturgid, sap exudes to relieve the tension. I examined several petals just after secretion commenced ; but I could not determine whether the nectar exuded from the papillae or elsewhere. In one case it was plainly exuding only from the disc, a small green fleshy ring surrounding the base of the ovary. Flies could not obtain nectar from the disc as it is hidden completely by the stamens. Possibly the " mosquitos " thrusting their slender probosces between the stamens obtain nectar from this source. I pressed several nectaries carefully with a smooth blunt needle, but no sap exuded. Still the fly doubtless exerts a different and more efficient pressure. The spiral thickening of the wall of the papilla is of value, I think, in enabling it to quickly regain its shape after being pressed. It may also help in liberating sap, for the ridges round the side of the bulbous top would diverge when the papilla was pressed down, and stretch the thinner membrane between them, thus making it more penetrable. The pollinator fly is doubtless able to apply suction as well as pressure. I have no evidence as to how the occasional visitors obtain juice (I think they do obtain it.)

Of what use are the purple lines on the petals ? Chiefly, I think, that with the ground color of the petals they produce a tint more pleasing to flies than a pure white or cream would be Indeed, I see no other use for them. They are superfluous as " honey guides "—the shape of the corolla cannot fail to guide the fly correctly. House flies as often walk across them as along them, when not seeking nectar. Each line stands immediately over one of the main veins of the petal ; so the question arises, is it a screen to cut off actinic rays ? The color is, however, as strongly developed on petals in the shade as on those in full sunlight ; and this seems contrary to the idea.

The flower is zygomorphic, but bears traces of descent from an actinomorphic blossom. The bases of the petals still occupy almost a complete circle, only the anterior two being slightly separated. If a bud be opened a few weeks before it is due to unfold the stamens will be found equal in length arranged in a circle round the pistil with anthers all facing inwards. These facts point clearly to an ancestor with bell-shaped corolla, and regular and equal stamens. In this connection it is worth noting that the buds are erect, only becoming horizontal shortly before anthesis. One is tempted to speculate how the oblique flower may have arisen : it looks so like a mutation. I am not prepared to discuss the question, but I fancy a careful study of the allies of the species would throw much light upon it. Chieranthera, for instance, has a regular corolla, but its stamens are all turned to one side.

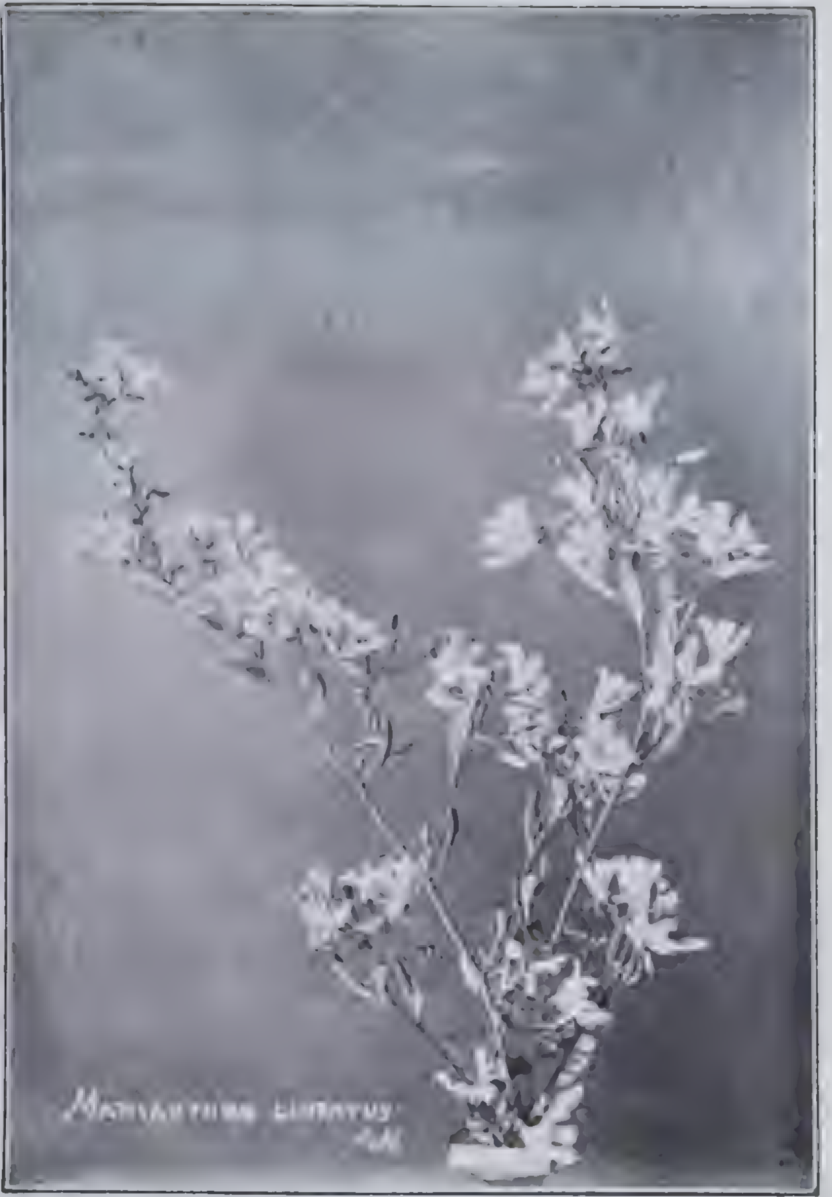
A brief consideration of the fruit will not be out of place, especially as it dehisces just at flowering time. It is an oblong bi-carpellary capsule about three-quarters of an inch in length. It dehisces at the top by both sutures, and the splitting gradually extends downwards, but seldom far. The seeds are flat reniform discs and lie loose in the capsule in four piles. The valves of the capsule are woody and the apex of each valve bears a small sharp somewhat recurved mucro or spike. This "spike" readily catches in one's coat, for instance, and as one moves away the fruit-bearing branch is pulled over. Suddenly, the spike lets go, and as the branch flies back seeds are jerked out of the capsule. Such is the arrangement for seed dispersal. I could not determine in the bush how far the seeds were thrown, so I experimented with a fruit-bearing branch at home. I did not succeed in getting the seeds to travel further than four feet. This seems a short distance, but I do not think they can be thrown further under natural conditions. Probably supplementary means of dispersal (*e.g.*, Ants) come into play. I have observed that even a strong wind does not shake seeds out of the capsule. Perhaps in the virgin bush marsupials browse upon these plants, and, frequently getting the capsules caught in their fur, are instrumental in scattering the seed. It is remarkable, however, if this is so, that the fruits should ripen at flowering time: it looks as though the animals would scatter the seeds while browsing on the flowers! I may here remark that sheep and horses are very fond of the flowers, they also eat the young shoots readily.

In January, 1907, I managed to spend an hour watching, at some distance, a number of flowering plants bearing ripe capsules at a spot as far from civilisation as I could get, where I have frequently seen kangaroos. On this occasion I saw a small bird visit two shrubs. It did not positively alight, but it evidently sought something. This suggests that the seeds *may* be scattered by birds visiting the shrubs in search of insects. The seeds certainly are scattered, usually long before flowering is over, and the shrubs sustain no damage (which negatives the browsing marsupial theory). The question requires much further investigation.

The immature fruits have a pungent and somewhat acrid taste, but this does not deter horses from eating them. Possibly it is a protection against native herbivora.

Several years ago I raised a plant from seed and got it to flower in my garden. Observations upon it have enabled me to state the time of duration of the flower, and a few other points requiring continuous watching. For several reasons I removed

Vol. III. Plate VI.



Flowering branches showing habit.

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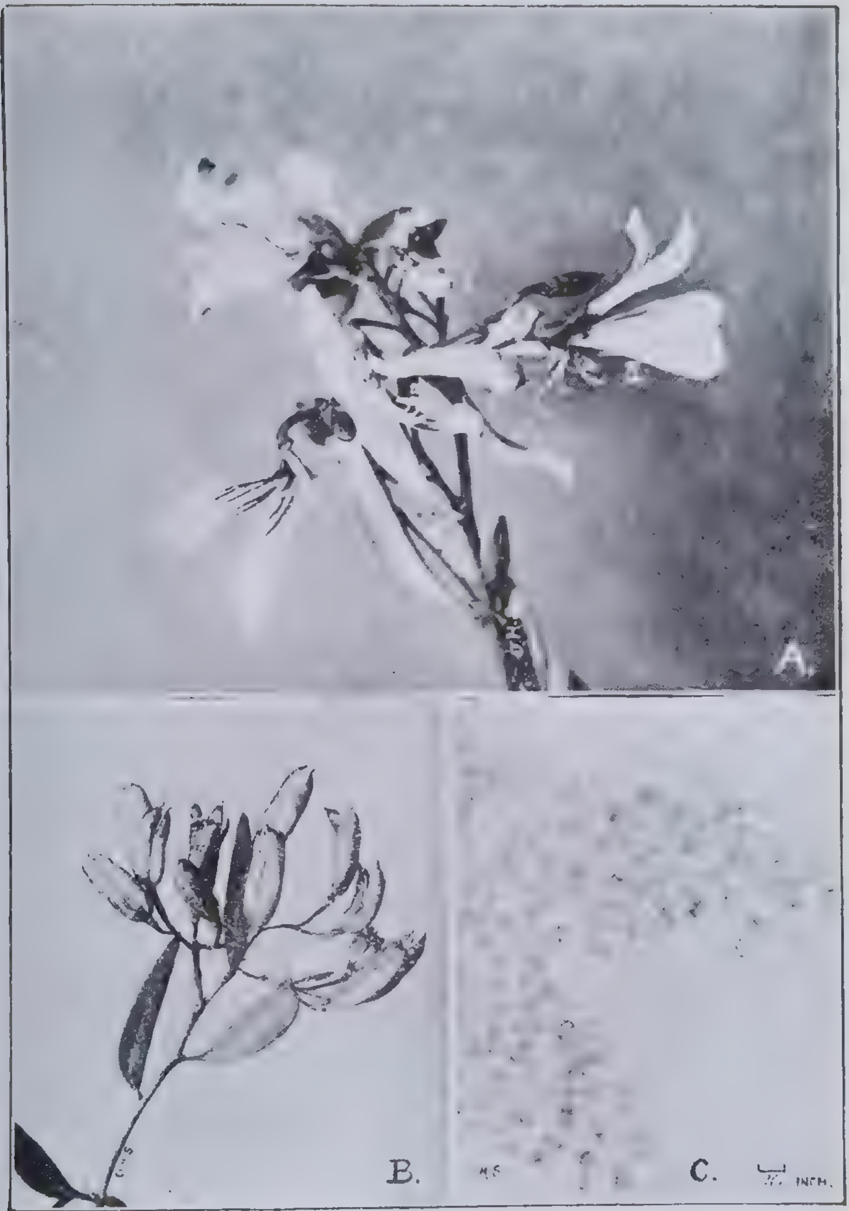

A, Dissected Flowers. 1. Bud with Corolla removed. 2. Flower in first stage, one petal removed. 3. Flower in second stage. a, Anthers. s, Sepals, st., Style. B, Fruits. C, Surface section of base of petal showing papillae.

this plant to another part of the garden after it had finished flowering and, unfortunately, it did not survive the operation.

NOTE ON NOMENCLATURE.—As some botanists are inclined to regard the plant here dealt with as *M. pictus*, Lindl., I think it well to state my reasons for calling it *M. lineatus*. Except perhaps in inflorescence, which, as a rule, is *not* dense, the plant agrees perfectly with Bentham's description of *M. lineatus* in Fl. Aust. In vigorous plants in good seasons the inflorescence *is decidedly dense*. Specimens I sent to England several years ago were compared with the specimens at the Natural History Museum, and at Kew, and were declared to agree perfectly with the specimens of *M. lineatus* there, but *not* with those of *M. pictus*. Material of the latter species is, however, scarce and somewhat unsatisfactory. Judging from Bentham's descriptions, the most decided difference between the two species seems to lie in the seeds, which are stated to be " nearly globular or angular " in *M. pictus*, and " closely packed and much flattened " in *M. lineatus*. In all my specimens the seeds (and even the ovules) are much flattened, except the uppermost and lowermost, which are rounded on one side so as to fill up the available space at the apex and base of the ovary.

Astronomical Notes.

By W. E. COOKE, M.A., Government Astronomer.

(Read before the Society, 12th October, 1909.)

Until comparatively recently Astronomers were mainly occupied with the motions and physical appearances of members of the solar system, but owing to the great improvements in instruments and especially to photographic developments, it has now become possible to seriously study the movements and distribution of stars throughout the universe.

At an Inter-National gathering of Astronomers held in Paris in 1887 it was resolved to lay the foundation for this new study by making a photographic survey of all stars down to at least the 11th magnitude, and the sky was divided into eighteen sections, each co-operating Observatory undertaking to catalogue all such objects within its allotted region. In 1900 another meeting was held to study progress, etc., and it was found that three of the Southern Observatories had failed to carry out their promises. In order to fill one of these gaps the new Observatory at Perth was invited to become one of the co-operating institutions, and the Western Australian Government pledged itself to carry out the necessary work. In April ,1909, a third meeting was held at Paris, at which I was present, and happened to be the sole Australian representative. Much useful work was accomplished in connection with the scheme, and arrangements made for giving the necessary assistance at weak points. I do not propose to enter into the technical details, but wish briefly to indicate the subject in which I was specially interested.

Underlying all astronomical research is the determination of the exact position and motions of a certain number of standard stars, to which all other positions and motions can be referred. These standard positions are determined by means of a transit or meridian circle. Hitherto there has been no co-ordination of this essential work, and the result is that we have on our shelves hundreds of catalogues, giving places for hundreds of thousands of stars at various epochs with varying degrees of exactness, but if we require really accurate positions of a dozen stars on any photograph covering a space of 2 degrees square in any part of the sky we cannot obtain them—in fact, probably cannot obtain more than one or two at the outside Yet there has been sufficient money and energy expended during the last century to give all the necessary information with the utmost accuracy, if it had been properly co-ordinated For some years I have had in mind a scheme for organising this branch, so as to avoid such waste in the future, and from the beginning have laid out my own work in accordance with such a scheme I was just commencing to try to persuade the few Southern Observatories to unite, when the opportunity came to place the matter before the most representative gathering of Astronomers that has ever been held The scheme was warmly supported by Sir David Gill, Professor Dyson, Professor Kapteyn, and others, and through their efforts was brought in a suitable manner before the Congress and carried unanimously. That means that gradually all the Observatories throughout the world engaged upon standard observations will cease casual work and lay out their programmes so that all will be co-ordinated. The main outline of the scheme is very simple. A certain definite list of stars, well distributed throughout the sky at the rate of 3 or 4 per square degree, will be selected, and it will be our united effort to obtain highly accurate positions of these at different epochs. As a basis a few, also well distributed at the rate of 1 in every five degrees square, will be selected as fundamental stars, and observed constantly with all the niceties known to modern science at certain first class Observatories. As a connecting link between the large list and the fundamentals a third list of stars, to be known as "intermediate stars" will be selected. The procedure will be: the positions of the fundamental stars will be determined in the sky absolutely, by reference to the actual equinox, and by actual comparison with the sun. The intermediate stars will be observed relatively to the fundamentals, and the main list will depend upon the intermediates. Stated thus it seems such an obvious procedure that one wonders it has not been adopted years ago, but it has only now been generally approved and a sub-committee appointed to arrange the details and help to have it carried into effect.

Notes on CATARRHACTES CHRYSOCOME (Forster) The Crested Penguin.

(Read before the Society by C. Price Conigrave, 14th September, 1909.)

I have great pleasure in recording the finding of a specimen of the Crested Penguin on Rottnest Island, near Fremantle, during the month of July last. Mr. Miller, of the Signal Station, found the bird, which had apparently only just expired, on the beach. Mr. Otto Lipfert, the Taxidermist to the Western Australian Museum, happened to be collecting on Rottnest Island at the time, and he was able to prepare the valuable skin. Mr. A. J. Campbell records this species as having been found at Hamelin, near Cape Leeuwin, and, as far as I can gather, this is only the second specimen to be secured in Western Australia. I regret that owing to my failing to obtain the consent of the Director of the Museum I am unable to exhibit this interesting specimen.

Notes on the Spawning of the SCHNAPPER *(Pagrus unicolor)* at Warnbro Sound (Safety Bay.)

(Read before the Society on the 14th December, 1909, by A. Abjornsson, Inspector of Fisheries.)

The Schnapper is a well-known fish along the coastline of Western Australia, and to a naturalist it affords scope for very interesting study, and especially so during the spawning season.

From various causes some of these fish spawn early and some late in the season. I have seen Schnappers caught with ripe roe in September and as late as February, but the height of the season is November. In the season of the year 1901 all line fishing and the taking of Schnapper was prohibited from the 1st of October to the 31st of December at Warnbro Sound.

We have the large-sized Schnapper with a hump on the nose, commonly called the "Old Man" Schnapper, varying in weight from 15 to 27 lbs., and known to fishermen to inhabit the deep waters of the Southern Ocean, only visiting our coast (that is in numbers) once a year for the purpose of spawning; and the lesser size, varying in weight from 5 to 10 lbs., commonly called the "Reef Schnapper," which may be met with along the coastline all the year round.

Before spawning the fish collect and form into line in such a way that the shoal when complete resembles a large-sized whale with a few stray leaders and several loose followers at the tail end. Lying closely packed together, the outside body of fish seems to provide the propelling power. This huge body of fishes rise, sink, and circle by slow movements, and when not disturbed will move along just under the surface at long intervals, leaving a trail of discolored water which, however, soon settles downward, but the oily surface shows the position of the shoal.

On November 1st, 1901, at 8 o'clock in the morning, I saw eight such shoals in straight lines north and south, a mile from the shore. There was a fairly even distance between each shoal. The weather being almost calm, these shoals were visible until noon.

How long the process of spawning extends I cannot say, as I have not yet seen or heard of a Schnapper being caught after spawning, although I surprised the fishing fleet there in two other seasons.

In December of several seasons I have seen eggs of fishes in different stages of development moved about in the eddying current, and on a calm day rise to within a few inches of the surface. There are also a great number of young Schnapper, varying in size and weight from 2½ to 5 ozs., beautifully shaded light pink and grey, with light blue spots. Warnbro Sound is rich in marine life, particularly crustaceans and worms for fish to feed on, and cuttlefish, squid, crabs, and starfish for the larger fish; in fact, it is an ideal hatching basin, with a depth of water from seven to eight fathoms, shelly and muddy bottom, protected by a line of reef, and broken only by a few passages. From this basin there is little chance of anything under the surface being swept away out to sea on account of the eddying current.

The smallest Schnapper I have seen with ripe roe I caught myself at the Sulphur Bay Buoy, Garden Island, in November, 1898. The fish weighed under 2 lbs.; and the largest I have seen with ripe roe weighed 27 lbs., yet I have seen an "Old Man" Schnapper out of season caught in Freshwater Bay, Swan River, weighing 31½ lbs.

—The—

Natural History & Science Society of Western Australia.

RULES.

1. The Society shall be called THE NATURAL HISTORY AND SCIENCE SOCIETY OF WESTERN AUSTRALIA.

2. The object of the Society shall be the study of Science in all its branches to be promoted by periodical meetings and field excursions, by the collection and preservation of specimens, by the formation of a library and the publication of a journal.

3. The Society shall consist of (*a*) Honorary Members, (*b*) Ordinary Members who may be Life Members, and (*c*) Junior Members. Membership shall be open to both sexes.

4. Honorary Members shall be persons not resident in Western Australia, who are distinguished for their attainments in and who have rendered signal service to Science. They shall be nominated and seconded by ordinary members and shall only be elected by the unanimous vote of those present at the meeting next following that whereat they were nominated. They shall be entitled to all the privileges of membership except voting and shall be limited in number to twelve.

5. (1) Ordinary Members shall be persons over the age of 21 years who are interested in the study of Science. (2) They shall be nominated and seconded in writing to the Council. Their nominations shall then be submitted at a meeting of the Society, and they shall be ballotted for at the next following. (3) Three dissentient votes or ⅓ of those voting shall debar a candidate from admission to the Society and any such person so debarred from becoming a member shall not be renominated for a period of six months.

6. Junior members shall be under the age of 21 years and their election shall be governed by the rules applying to ordinary members. They shall be entitled to all the privileges of membership except that of voting.

7. Ordinary members shall pay an annual subscription of 10s 6d., or may become Life members on payment of ten guineas at any one time. Junior members shall pay an annual subscription of five shillings.

8. The financial and business year of the Society shall begin on the 1st July, on which date all subscriptions for the ensuing year become due.

9. The management of the Society shall be vested in a Council consisting of a President, two Vice-Presidents, a Secretary, a Treasurer, and five ordinary members, all of whom shall be elected annually by the members of the Society at the Annual General Meeting.

10. The Council shall have the control of all the property of the Society, shall be responsible for the due observance of all the rules of the Society; shall frame, rescind and alter Bye-laws, in accordance with these rules, and shall decide any matter not covered by the rules or Bye-laws; shall appoint from time to time from its ranks a Librarian and Editors of the journal, and may by a two-thirds vote of the whole Council remove any name from the Members' Roll, with or without assigning reasons for such action.

11. At all meetings of the Council, four members shall form a quorum. Should any member fail to attend three consecutive Council meetings without satisfactory reason being given, his position shall be declared vacant. Vacancies in the Council from this or any other cause during the year shall be filled by the Council at its next meeting.

12. The Secretary shall conduct the correspondence of the Society, attend all meetings, take minutes of the proceedings, keep a register of all the names and addresses of the members, issue notices of all meetings of the Society or Council, and otherwise perform the usual secretarial duties.

13. The Treasurer shall receive all sums of money due to the Society, pay such accounts as may be ordered by the Council, keep an account of such receipts and payments, and produce the same when required by the Council. At the close of each financial year he shall prepare a statement for the past year which shall be submitted to the Society's Auditors for verification.

14. The Librarian shall have the custody of all books, instruments, specimens, or other property of the Society, and shall issue the same for the use of members subject to the Bye-laws.

15. The Annual General Meeting shall be held in July of each year for the purpose of nominating and electing all members of Council as well as two Auditors for the ensuing twelve months, and for the conduct of such other business as may arise. Thereat the Council shall submit a report of the Proceedings of the past year, and the Treasurer his financial statement duly certified by the Auditors Seven members shall constitute a quorum at this or any other meeting of the Society.

16. Special General Meetings to discuss any question of importance to the Society may be held by direction of the Council in response to a requisition signed by at least five members. A fortnight's notice of such meeting shall be given in writing to all members, such notice to state the business to be discussed at the meeting.

17. Ordinary meetings for the reading and discussion of papers, the exhibition of specimens, the election of members and other routine business of the Society shall be held once a month throughout the year.

18. All elections of office-bearers or of new members shall be by ballot

19. The journal of the Society shall be published at such times as the Council shall direct. It shall contain a resumé of the proceedings of each meeting of the Society, together with all papers read before the Society. Such papers shall at the discretion of the Council be printed in full or in abstract.

20. Additions to or alterations of existing rules shall only be made by a two-thirds majority of the members present at an Annual or Special General meeting, and after a month's written notice of such additions or alterations has been issued in writing to each member.

21. In the event of the Society ceasing to exist the last elected Council shall dispose of all the property of the Society as they deem best in the interests of Science.

BYE-LAWS.

1. The scope, aims, and extent of the Society shall comprise all branches of Science, but shall exclude Theology and Politics, which shall be absolutely debarred from introduction in any shape or form from all meetings of the Society.

2. Nominations of any Junior Member shall include statement as to date of birth of candidate. On the 30th June next following his 21st birthday he automatically ceases to be a Junior Member, and on payment of the ordinary subscription he may become an Ordinary Member.

PRIVILEGES OF MEMBERS.

3. (*a*) Ordinary Members have the right to be present, to state their opinions and to vote, at all meetings of the Society; to propose Candidates for admission

to the Society, to introduce one visitor at any meeting, provided such visitor is not introduced at more than three meetings in one year; to have access and to introduce scientific strangers to the Library; and all members who have paid their annual contribution shall be entitled to one copy of each Journal published during the year. (*b*) The composition for Life Membership, in lieu of the Annual contribution, shall be £10 10s. (*c*) A member shall not be eligible to any office in the Society or Council, unless he shall have paid his Annual Contribution for the year previous to that in which the election takes place.

4. No member shall be entitled to vote on any occasion whatsoever if his subscription be six months overdue. Should any member's subscription be twelve months overdue his name shall be posted in the Society's room, and he shall cease to become a member, but may be re-admitted without formal election on payment of all outstanding arrears within three months.

5. A Roll of Members shall be kept in which Members shall subscribe the following obligation:—

> I, the undersigned, do hereby engage that I will endeavour to promot the welfare of the Natural History and Science Society of Western Australia, and to observe its Rules and Bye-Laws, as long as I shall remain a a Member thereof.
> (As witness my signature to Roll of Membership)

(Signed) ....
Address ....
Date.. ....

6. Every new member shall receive due notice of his election and be supplied with a copy of its Laws. He shall not be entitled to enjoy any privilege of the Society, nor shall his name be printed in its List of Members until he shall have paid his first Annual Subscription, and signed the Obligation and Roll of Members.

7. No Member shall be at liberty to withdraw from the Society without previously giving notice in writing to the Secretary of his intention to withdraw, and returning all books and other property of the Society in his possession. Members shall be liable for the payment of all subscriptions due from them up to the date at which they give written notice of their intention to withdraw from the Society.

PRESIDENT.

8. It shall be the duty of the President to preside over all meetings, to regulate all debates and discussions, to state and put questions which shall have been moved, to call for reports from Committees and others, to cause any meetings of the Society or Council to be summoned when he may think necessary, or whenever a requisition to that effect is presented, as provided for in the Rules and Bye-Laws, and generally to see to the carrying out of the provisions of the Rules and Bye-Laws of the Society. In case of an equality of votes the President shall have a double or casting vote.

VICE-PRESIDENTS.

9. (*a*) In the absence of the President, one of the Vice-Presidents shall take his place, and shall for the time being have all the authority, power and privilege of the President. (*b*) In the absence of the Vice-Presidents, some other member of the Council shall preside and if no member of the Council be present at an Ordinary Meeting, the members shall appoint by a majority to be Chairman such Senior Member as those present shall see fit, and the Member so presiding shall for the time being have all the authority, power and privilege of the President.

SECRETARY.

10. It shall be the duty of the Secretary to keep a list of all members of the Society, together with their addresses, to attend all, and summon meetings, when necessary, of the Society and the Council; to conduct and produce to the Council

all the correspondence in any way connected with the Society at the next meeting after such correspondence shall have been received or taken place ; to take minutes of the proceedings at meetings of the Society and the Council ; to assist in editing the Journal or Transactions of the Society ; to send out all necessary notices and circulars. to distribute such copies of the Society's publications to such persons, Societies, and Institutions as the Council shall direct ; to keep a petty cash book fully entered up, as to expenditure for postages, and necessary items, which shall be approved by the Council to be paid by him, out of such amounts as the Treasurer shall be authorised to hand to him for the purpose from time to time by the Council ; and to produce the book at all meetings of the Council, and, generally to act under the direction of the Council in all matters connected with the welfare of the Society.

11. In the event of the absence from any meeting of the Society, or the Council, minutes of the proceedings shall be taken by a Member of the Council, whom the President shall appoint for the occasion, and such member shall not refuse to act.

TREASURER.

12. The Treasurer shall keep a list of all Members of the Society showing the date up to which each Member shall have paid his annual subscription.

13. All moneys received on the Society's behalf shall be paid into an account in the name of the Society in the Government Savings Bank, Perth.

14. No monies shall be drawn out of the said account except by cheque drawn by the Treasurer, and countersigned by the Secretary, and no claims on the Society shall be paid except by such cheques, or out of the petty cash from time to time authorised by the Council to be paid into the hands of the Secretary.

15. All accounts not paid out of petty cash must be submitted to, and authorised by the Council before payment.

LIBRARIAN.

16. The Librarian shall keep a catalogue up to date of all books, instruments, specimens, and other property of the Society, with the name of donors, or how obtained. He shall keep a record of all property issued to members, and see that the same are returned in good order and condition.

LIBRARY REGULATIONS.

17. No Member shall, without special permission of the Council, be allowed to borrow more than two volumes at one time from the library or to retain any volume longer than one month ; but if such volume be not required by any other Member, it may be re-issued to such borrower at the discretion of the Librarian until the following monthly meeting.

18. If any book or property be torn, injured, lost, or not forthcoming when demanded by the Librarian, the Council shall demand full compensation for such injury or loss by the borrower.

19. The Librarian shall call in all books, instruments or other property, borrowed from the Society, before the 15th day of June in each year, so that the same can be properly checked for the Annnal Meeting Report. In all cases in which the borrowers do not return their borrowed property at the ensuing monthly meeting, the Librarian shall by notice demand the return of same, and if such notice be not complied with, he shall report the same to the Council, who shall then direct a second notice to be sent to the Member retaining such book or property, and in case the same be not returned before the next monthly meeting, such Member shall in future be disqualified from borrowing from the Library without the special permission of the Council.

20. The Library shall be open to Members at the monthly meetings from 7.30 o'clock to 10 o'clock p.m., or such other hours as may be arranged by the Council.

21. No stranger shall be allowed access to the Library, unless introduced by a Member, but a note addressed to the Librarian or Secretary shall be deemed suffi-

cient introduction to use any book, etc., during the meeting of the Society, but he shall not be permitted to take away any book or property of the Society without the permission of the Council.

22. The Council shall cause a "Library and Property Borrowing Book" to be prepared in which Members borrowing anything belonging to the Society shall sign their names and date on receiving the article stipulated, such signatures shall be proof of Members being in possession of same; on returning anything to the Librarian, he shall see that it is in good condition and attach his name or initials with date in the column provided, thus relieving the borrower of responsibility.

23. Should the Librarian observe that any loss or damage has been sustained by the article borrowed, he shall refuse to sign for it, but shall give a receipt and at the earliest opportunity refer the matter to the Council who shall proceed to deal with it, as provided for in Bye-Law 19 of the Library Regulations.

24. A borrower's signature in all cases to be taken as proof of receiving in good condition.

25. No specimens shall under any conditions be allowed to be taken from the Society's room.

EXCURSIONS.

26. The Leaders of all Excursions shall be required to furnish a written report concerning it, to the next ensuing meeting afterwards, and members attending the same, should exhibit all specimens of interest collected thereat, so that they may be recorded if necessary.

CONDUCT OF BUSINESS AT MEETINGS.

27. The Ordinary Meetings of the Society shall be held on the second Tuesday in each month except July, or at such other days or times as the Council shall from time to time direct. The Chair shall be taken punctually at 8 o'clock, and no new business shall be taken after 10 o'clock.

28. At the Ordinary Meetings the Order of Business shall be :—

1. Members introducing visitors shall introduce them to the President when their names shall be read aloud.
2. The Minutes of the last Meeting shall be read aloud by the Secretary, proposed for confirmation by the Meeting and signed by the President.
3. Nominations for Membership shall be read out.
4. Election of new Members, who if required shall sign the Roll Book.
5. Report of Excursions from Leaders.
6. The presents made to the Society since the last Meeting shall be announced and exhibited.
7. Reading of any Natural History notes of interest, either local or foreign, and the list of Exhibits.
8. Exhibition of specimens etc., shall be made, Exhibitors furnishing the the Secretary with a list of same previously, which he will read aloud, also for incorporation in the Records of the Society. The examination of the exhibits shall form the concluding act of the Meetings.
9. As soon as the general business is finished the President shall call upon any Member to read any "Paper" of which notice has been given.

29. Members shall have the privilege of reading before the Society accounts of experiments, observations, and researches conducted by themselves, or original papers on subjects within the scope of the Society, or descriptions of recent discoveries, or notes of general scientific interest. No vote of thanks to any Member for his "Paper" shall be proposed.

30. If any Member should be unable to attend for the purpose of reading his paper, he may delegate to any Member of the Society the reading thereof, and his right of reply.

31. Any Member desirous of reading a paper shall give notice in writing to the Secretary seven days before the Meeting at which he desires it to be read, its title and the time its reading will occupy, so that it can be included in the monthly notification to Members, etc.

32. The Council may for any special reason permit a paper as is described in Bye-Law 29 not written by a Member of the Society to be read by the Secretary or other Member, and if considered more beneficial to Science, they may specially permit its author to read it.

33. In speaking to any debate, discussion, or paper read, no Member shall introduce any matter, extraneous or foreign to the subject at issue; should any Member so offend, he shall at once be called to Order by the President, and requested to confine his remarks to the subject at issue, or be debarred from further speaking.

34. Any Paper which shall be read at any Meeting of the Society and accepted for publication, shall become the property of the Society unless otherwise stipulated before the reading thereof; subject to the finances of the Society allowing and the Council's approval thereof, authors of papers published shall be allowed not more than twenty-five reprints in addition to any number they may wish to pay for, personally, with the Council's permission and sanction.

35. No Stranger shall speak at a meeting of the Society unless specially invited to do so by the President.

NOTICES.

36 Every notice required by these Rules to be given, may be given through the post, or by advertisement in such daily newspapers as may be determined upon by the Council.

/12
MUSEUM MELBOURNE

JOURNAL

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Natural History

AND

Science Society

OF WESTERN AUSTRALIA.

The Author of each Article is alone responsible for the facts and opinions recorded.

Vol. III., No. 2.—January, 1911.

Perth:
V. K. Jones & Co., Printers, 859 Hay Street.
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THE
Natural History and Science Society
OF
WESTERN AUSTRALIA.

OFFICERS 1910-11.

Patron:
His Excellency the Governor, Sir Gerald Strickland, K.C.M.G.

President:
A. Gibb Maitland, F.G.S.

Vice-Presidents:
Frank Tratman, M.D., B.S
H. Murray Giles, F.E S., F.L.S. (N.S.W.).

Council:
W E Cooke, M.A., F.R.A.S.
T. N. Lee, M.A.
A. O. Watkins.
W. Catton Grasby F.L.S.
E. S. Simpson, B.E., F.C.S.
F. G. Brown, B.A., B.Sc.
Resigned, Dec., 1910.)

Hon. Treasurer:
C. G. Thorp, M.B., C.M.

Hon. Lirarian:
H. Murray Giles, F.E.S.

Editors of Journal:
The President and Vice-Presidents.

Acting Hon. Secretary:
E. S. Simpson, B.E., F.C.S.

General Meetings of the Society are held on the second Tuesday in each month.

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ERRATA.—Part I.

Page 5, line 38 from top, for *discussion* read *discussing.*

Page 6, line 38 from top, prefix * should be ‡.

Page 6, line 40 from top, for *S hool* read *School.*

Page 20, line 32 from top, for *Mutilla* read *Ephutomorpha.*

Page 27, line 25 from top, for *which have only* 15 *pairs* read *which have only* 14 *and* 15 *pairs.*

Page 56, Plate II.—Unfortunately the names on plate are transposed. Fig. I should read *Eragrostis eriopoda*; Fig. 2 *Plagianthus Helmsii.*

Page 58, line 6 from top, for *Pittosoporaceae* read *Pittosporaceae.*

The Council is anxious to obtain, by gift or purchase, copies of the following journals:—

Mueller Botanic Society, Parts 1, 2, 3, 4, 5, 6.

W.A. Natural History Society, Part 3.

Proceedings of the Natural History and Science Society.

ANNUAL REPORT.

LADIES AND GENTLEMEN,

Your Council has much pleasure in submitting the Annual Report and Financial Statement for the year ending 30th June' 1910.

We were fortunate in beginning the year with a credit balance of £51 12 . 9d. The actual receipts amounted to £26 10s. 11d., which includes the Government grant for the years 1908 and 1909, which was not paid until July, 1909. The expenditure for the year amounts to £86 18s. 1d., leaving a credit balance of £1 5s. 7d. The Government grant for this year has not yet been paid. The great cost of printing the last number of the *Journal* has been the cause of the swallowing up of so much of our funds, and in this connection the Council feels it is its duty to remind members that it is only with an even larger membership than we have at present that it will become possible to publish the *Journal* more frequently than has hitherto been the case. It is to be hoped that the finances will in future enable the Council to issue the *Journal* as a semi-annual or quarterly publication.

The number of members is at present 90, of whom 6 are honorary—an increase of 29 during the year. This increase is very encouraging, particularly as many of those who have affiliated themselves with the Society are now renewing an active interest in its work, which commenced in some of the earlier societies from which our body has risen. With the membership rapidly increasing as it is at present, every hope may be expressed that the Society has entered upon a most successful era.

The year under review has been one in which the scope and aims of the Society have been a great deal altered and enlarged. This alteration is expressed in its name, which was decided upon after many other suggestions had been considered. The change of title has proved to be a wise one, having increased the interest of old members, attracted many new ones, and considerably widened our outlook. We look forward to the time when we shall still further expand and develop into the Royal Society of Western Australia.

The business of the Council during the year has been particularly arduous. New rules and bye-laws have been drafted and brought into force. In addition the removal of the Society from the W.A. Museum, the labour in connection with the Library and collection, and the hundred other matters that have demanded attention, have necessitated very frequent meetings and a great amount of personal exertion and sacrifice on the part of some of the Council, who have given up many evenings and worked hard to get things in order.

It will be remembered that the Society took up the question of the preservation of Barrow Island as a Fauna and Flora Reserve. This island is of the greatest scientific interest, as it is the sole habitat of several species of animals. It was proposed by the Government to lease the island for industrial purposes, but at the suggestion of the Council the authorities decided to act otherwise, and we have much pleasure in stating that this important area has now been gazetted as a strict game preserve for all time.

The Council regrets for many reasons that the Society had to vacate its old quarters at the Museum, but this was necessitated by the inability to obtain at the Museum essential facilities such as a suitable room for general meetings and unrestricted entrance at any reasonable time to the Society's quarters. The Director of Technical Education kindly provided the Society with temporary accommodation in the Technical School during the Christmas vacation, and after that, through the courtesy of the Honourable the Minister for Agriculture, the Society obtained the use of the very convenient rooms in the Department of Agriculture which we at present occupy.

The Council has met twenty-five times during the year, and there have been twelve general meetings of the Society, at which many important papers have been read. Excursions have been conducted to various localities in the Darling Ranges and elsewhere. The attendance was encouraging, but it is to be hoped that even more members will attend during the coming year. Visits were also paid to several of the public scientific institutions, including the Observatory, the Laboratory of the Central Board of Health, the Geological Survey Offices, and Laboratory, and the Museum.

Arrangements have been made for a series of Demonstrations in various branches of practical science to be given during the coming season by various members recognised as authorities in their respective branches of study. One such will be given in each month. They should prove of great interest and assistance to the members.

On the resignation of the Secretary, Mr. L. Glauert, Mr. C. Price Conigrave was appointed to the vacant position in an honorary capacity and with an *ex-officio* seat on the Council, under the new rules of the Society.

The Council feels that the Society is to be congratulated upon the work of the past year. A very hopeful and encouraging future seems to be open to us all. The Council would urge upon members the desirability not only of pursuing investigations into questions of local scientific interest, but also of placing on record the results of their work for the benefit of other investigators.

FRANK TRATMAN,
PRESIDENT.
C. PRICE CONIGRAVE,
HONORARY SECRETARY.

Statement of Receipts and Expenditure

OF THE

Natural History and Science Society of Western Australia,

For the Year Ending 30th June, 1910.

RECEIPTS.				£	s.	d.	£	s.	d.
To Balance from last year—									
In Bank.				45	16	6			
,, Hand Subscriptions				3	13	6			
,, ,, Dredging Expedition				1	6	0			
,, ,, Sale of Journal					1	6			
,, ,, Petty Cash					7	9			
Subscriptions—							51	5	3
42 at 10s. 6d.	22	1	0						
1 at 5s.		5	0						
				22	6	0			
For 1910-11—									
9 at 10s. 6d.	4	14	6						
1 at 5s.		5	0						
				4	19	6			
							27	5	6
Government Grant				7	10	0			
North Beach Excursion				1	4	0			
Sale of Journals				1	2	6			
Petty Cash Repayment					7	6			
Interest on Bank A/c					9	11			
							10	13	11
							£89	4	8

EXPENDITURE.	£	s.	d.	£	s.	d.
By Printing	36	15	9			
Typewriter and Sundries	15	4	0			
Typewriting	1	10	4			
Bookbinding	6	2	6			
Lantern Slides		13	9			
Furniture (Carpenter)	1	2	6			
Excursion (North Beach)	3	10	0			
Cartage	1	12	9			
Attendant	3	15	0			
Secretary (Honorarium)	5	5	0			
Bank Charges		11	6			
Petty Cash, Postages and Sundries	10	15	0			
				86	18	1
Balance at Bank	1	5	7			
Cash in Hand	1	1	0			
				2	6	7
				£89	4	8

Presidential Address.

BY DR. TRATMAN.

(Delivered June 14th, 1910.)

Ladies and Gentlemen,

The year during which I have had the honour of being President of the Natural History and Science Society of Western Australia has been one in which its characteristics and aims have been a great deal altered and enlarged. This alteration is expressed by its name, which was finally chosen after many other suggestions had been discussed at the meeting at which the new rules, drawn up by the Council, were passed. This change has proved to be an exceedingly wise one, having greatly increased the interest of members, brought in a stream of new ones, widened the outlook and generally raised the scientific tone of our meetings.

We look forward to the time when we shall still further expand and become a Royal Society. At this place I wish to point out that the work of the Council during this session has been by no means light. The preparation of the rules, which are adopted, and the bye-laws, for which the Council are responsible; the business in regard to our removal from the Museum, the work in connection with our library and collections, and a hundred other matters, have necessitated very frequent meetings, and a great deal of personal work by some of the members, who have given up many evenings and worked hard to get things into order. I wish to record my great thanks to the members of the Council, who have one and all worked hard and truly in the interest of the Society and its work. Some members may possibly have noticed the absence from our meetings of the tea and cake. This was necessary from financial considerations, otherwise it would have been a pleasant way of terminating our meetings. Although the social side of life is with us a secondary consideration, it should, I think, be cultivated as far as is compatible with the work for which we exist.

However innocent we may look, I believe I should not be far wrong in saying that we all like cake, and those members who have been good enough to produce it for us at the psychological moment, as happened, for instance, last Saturday, must almost have felt the silent blessings which were rising all aronud them. I think it likely that some kind of semi-public gathering of a social character held once a year might make our work better known and bring us in more members.

It will be remembered that the Society took up the question of the preservation of Barrow Island as a fauna and flora reserve. The island is of great scientific importance as it contains species of animals which are unknown in any other part of the world. It was proposed by the Government to include the island in a lease to be granted to Mr. Barron Rodway. The Council entrusted the matter to me. Through the introduction of Mr. Arthur Male, M.L.A, I had an interview with the Colonial Secretary, Mr. Connolly who listened to my arguments with sympathy. As a result, on the 9th March, I received a letter from the Under-Secretary, saying that the request that the island should be excluded from the lease was granted and also that it would be declared a Class A Reserve, which means that its purpose cannot be changed without an Act of Parliament.

It is necessary for me now to say something about our change of quarters. For a Society of this kind to be carried on successfully two rooms are necessary—one, a large one, in which general meetings can be held; another, smaller one, in which our library and collections can ke kept and in which Council meetings can be held. This room must be for our use exclusively, while the lecture-room need not be. On the 8th of September last we received a notice from the Museum Committee that the lecture room used by us at the Museum would be required for Museum purposes. Endeavours were made to find another room in the same building. Rooms were there, but we could not get granted to us the essential condition that the small room should be accessible at all times to members and the public. It was plain, therefore, that we had to leave the Museum. Hopes were held out to us by the Director of Technical Education that he might be able to give us accommodation at the new Technical School, but he was not able to fulfil his words. The Hon. the Minister for Agriculture, Mr. Mitchell, and his Under-Secretary, Mr. McNulty, received us gladly and with sympathy, and have granted us the use of the room in which we now are for our meetings, and also the small room for our exclusive use, in which are stored our Library and Collections. This room is now open to members and to the public at all times, and it is hoped that good use will be made of it, for we have a really good library.

Ladies and Gentlemen, this slight review of the year that has passed shows that this Society has become re-invigorated. We have had a series of papers read before us of high standard and scientific value. Our excursions have been well attended and of great interest; our meetings also have been well attended. The number of members has increased from 61 to 90. We have permanent and reasonably comfortable quarters and I have personally the confident feeling that a solid foundation has this year been laid for the future to build upon.

Proceedings, January to December, 1910.

January 8.—Excursion to Mundijong; Dr. F. Tratman, leader.

January 11.—General meeting; chairman, Dr. F. Tratman. Papers:—"Cross-breeding of Maize and the Mendelian Theory," by G. A. Pfister; "A Plea for an Ethnological Survey of Western Australia," and "Notes upon the Aboriginal Dancing Boards of Western Australia," by W. D. Campbell, F.G.S., L.S.

January 22.—Excursion to Canning Bridge; Mr. H. M. Giles, leader.

February 8.—General meeting; chairman, Dr. F. Tratman. Exhibits: Mr. O. Lipfert exhibited paintings of male and female of *Olisthops cyanomelas* (Herring kale) caught at Carnac. Paper: "Some Further Avenues of Research open to Local Students," by F. G. Brown, B.A.

March 5.—Excursion to North Beach; Mr. E. S. Simpson, leader.

March 8. General meeting; chairman, Dr. F. Tratman. Papers:—"Suggestions for the Formation of a Hydro-geological Survey of W.A.," by W. D. Campbell, L.S., F.G.S.; "Force of Gravity," by A. F. Smith, C.E.

April 2.—Excursion to Jandakot; Mr. H. M. Giles, leader.

April 12. General meeting; chairman, Dr. F. Tratman. Paper:—"A Chat about Insects," by W. Catton Grasby, F.L.S. Exhibits: Mr. H. M. Giles exhibited slides showing mimicry of flowers by insects, fertilisation of flowers by insects, etc.

April 16.—Visit to the Observatory, under the direction of Mr. W. E. Cooke, M.A., F.R.A.S., Government Astronomer.

April 30.—Visit to the Laboratory of the Central Board of Health, under the direction of Dr. Muriel Davies, Acting-Government Pathologist and Bacteriologist.

May 10. General meeting; chairman, Dr. F. Tratman. Paper: "The Origin, History and Work of the Geological Survey of Western Australia," by A. Gibb Maitland, F.G.S.

June 11.—Visit to the Offices and Laboratory of the Geological Survey, under the direction of Mr. A. Gibb Maitland, F.G.S., Government Geologist.

June 14.—General meeting; chairman, Dr. F. Tratman. The Presidential Address was delivered by Dr. Frank Tratman. Paper was read by Mr. J. G. Hay on the "Fauna and Flora Reserves of Australia," in which he showed the great necessity of adequately protecting our fast-disappearing birds, marsupials, and indigenous flora. Although at the very inception of the Australasian Association for the Advancement of Science, a very big and influential committee had been appointed, but little practical work had resulted, saving a reserve at Kangaroo Island, and one at Wilson's Promontory, with certain national parks largely used as recreation grounds. In this State, the Fauna and Flora Reserve of 160,000 acres at North Dandalup, granted by Sir John Forrest's administration, had now been entirely lost, owing to the inaction of the Society, and the reserve was now given up for the supply of Government railway sleepers. After considerable discussion, motions were carried that the Society in conjunction with the Association for the Advancement of Science, should make strenuous efforts to preserve the native fauna and flora of the State. Exhibits:—Mr. W. E. Cooke exhibited a model of the orbits of the earth and Halley's comet.

June 25.—Visit to the West Australian Museum.

June 28. Demonstration:—"Collection and Study of Flowering Plants," by Dr. Alex. Morrison, F.R.C.P., F.R.C.S.

July 19.—Annual meeting.

July 23.—Demonstration:—"Orchids," by F. G. Brown, B.A.

August 16.—General meeting; chairman, Mr. A. Gibb Maitland. Paper: "Pilbarite, a new mineral from the Pilbarra Goldfield," by E. S. Simpson, B.E., F.C.S.

August 20.—Excursion to Mahogany Creek, Mr. E. S. Simpson, leader.

August 30.—Demonstration:—"Insects, collecting, labelling and preserving, with Notes on Habits and Localities," by H. Murray Giles, F.E.S.

September 3. Excursion to Boya; Dr. F. Tratman, leader.

September 17.—Excursion to Zig-Zag; A. Gibb Maitland, leader.

September 19.—General meeting; chairman, Mr. A. Gibb Maitland. Paper:—"Notes on Radium," by W. J. Hancock, M.I.C.E.

October 1. Excursion to Gosnells; Dr. C. G. Thorp, leader.

October 11.—General meeting; chairman, Mr. H. Murray Giles. Reports of excursions:—Mahogany Creek, by E. S. Simpson; Boya, by Dr. F. Tratman. Exhibits:—Mr. H. M.

Giles exhibited ten species of Rhopalocera not previously recorded from W.A., viz., *Euplœa corrina*, *Melanitis leda*, *Ypthima arctous*, *Hypocysta irius*, *Junonia albicincta*, *Acræa andromacha*, *Terias hecabe*, *Catopsilia pomona*, *Hesperilla sp.*, *Telicota sp.* These were all from Napier Broome Bay and Koolan Island; also a wasp, *Polistes sp.*, and nest from the same locality. Dr. F. Tratman exhibited from Boya, *Prassophyllum elatum*, *Diuris setacea*, *Drosera pallida*, *D. neesii*, *Hakea undulata*, *Isopogon roseus*, *Caladenia filamentosa*, *Tribonanthes longipetala*; from Zig-Zag, *Prassophyllum striata*, *Caladenia menziesii*, *Pimelea argentea*, *Verticordia acerosa*, *Diplopeltis huegelii*; from Gosnells, *Microtis parviflora*, *Verticordia insignis*, *Calothamnus torulosus*, *Microcorys longifolia*, *Glossodia emarginata*, *Thelymitra crinita*, *T. villosa*, *Utricularia hookeri*, *Stylidium carnosum*, *Thomasia glutinosa*, *T. montana*. Mr. E. S. Simpson exhibited Microcline-perthite and Microcline pegmatite from Mahogany Creek; Schlieren in quartz diorite from Boya; Pilbarite in albite matrix from Wodgina Wiikite with 1.1 per cent. scandium oxide from Impilaks, Finland.

October 15.—Visit to Messrs. Cuming, Smith and Co.'s Superphosphate and Acid Works, at West Guildford.

October 25. Demonstration: "Collection, Preservation and Study of Minerals," by E. S. Simpson.

October 29. Excursion to Boya; Mr H. M. Giles, leader.

November 8. General meeting; chairman, Mr. A. Gibb Maitland. Reports of excursions:—Gosnells, by Dr. C. G. Thorp; Boya, by Mr. H. M. Giles. Exhibits: -Mr E. S. Simpon exhibited fibrous Talc and a bronze colored Vermiculite from Goomalling.

November 12. Excursion to Swan View; Mr. A. Gibb Maitland, leader.

November 22. -Demonstration:—"Classification of Flowering Plants," by Dr. F. Tratman.

November 26. Excursion to Cannington; Miss Adcock, leader.

December 10.—Excursion to Maddington; Mr. A. J. Hall, leader.

December 13. -General meeting; chairman, Mr. H. Murray Giles. Report of excursion: Maddington, by Mr. A. J. Hall. Exhibits:—Miss Fuller exhibited *Eucalyptus torquata* from Coolgardie, and paintings of this and of *E. macrocarpa* and *E. pyriformis*. Papers:—"Second Abstract of the Reports of the German Expedition of 1905 to S.W. Australia," by Dr. W. Michaelsen; "Notes on some W.A. Eucalypts, with descriptions of New Species," by J. H. Maiden, F.L.S., Government Botanist, N.S.W.

Excursions.

MAHOGANY CREEK—20TH AUGUST, 1910.

LEADER, MR. E. S. SIMPSON.

GEOLOGY.—The ridges in the vicinity of the Mahogany Creek station are covered with a mantle of laterite several feet thick. A small portion of this was sufficiently rich in iron to have been used for flux at the Fremantle smelters some years ago. At present large quantities of more aluminous laterite are being sent to Perth for streets and footpaths. The party proceeded to the granite quarry about one mile south-east of the station. The scene of operations is a small boss of grey granite rising out of low lying sandy soil. This is the only granite outcrop seen in the vicinity. From the quarry paving blocks are made for use in street gutters in Perth. The granite is a somewhat fine grained rock composed of microcline, oligoclase and quartz in about equal proportions, together with a little biotite. Veinlets of epidote are seen in some parts of the outcrop and a pegmatite vein about two feet wide crosses the boss almost in the centre. The pegmatite is composed of quartz and coarsely crystallised felspar, the latter being microcline-perthite, *i.e.*, microcline with narrow interlaminations of albite. A graphic intergrowth of microcline and quartz was also seen in parts of this vein. No rare minerals were seen. The writers' experience is that these do not as a rule occur in the orthoclase or microcline pegmatite associated with potash granites, such as those of Northampton or the Darling Ranges, but are almost invariably to be found in the albite pegmatites, associated with soda granites, such as are seen at Wodgina and Moolyella in the North-West or Ravensthorpe, in the south.

BOTANY. -For these notes I am indebted to Dr. Tratman. The season being so late this year, the flowers were not advanced, while many of them which had been in full bloom had again shut up their blossoms to avoid the cold air. Of orchids, the most conspicuous was the *Diuris longifolia*. It cannot be too much insisted upon that a botanical specimen of an orchid must include the whole of the parts under the ground. It will then be found that, so far as is now known, with one single exception, they have one or more distinctive underground tubers. The exception is *Diuris longifolia*, which never has a bulb, but only a group of more or less tuberous fibres. This applies only to this one species of the genus, *D. setacea* and *D. pauciflora* having well marked tubers. Here is an interesting object of research for members—to find out whether *Diuris longifolia* is, in fact, the only orchid which has no bulb. A handsome plant also found is the *Acacia nervosa*, having a spike of yellow balls and pricky one-nerved leaves. Three of the beautiful red creepers, the *Kennedyas*, were to be found; they all have compound trefoil leaves and red blossoms. *K. prostrata* is the commonest, having solitary flowers, like *K. stirlingii*, while *K. coccinea* has bright clusters of coral red. The only proteaceous plant in blossom was *Hakea lissocarpha*, one of those low shrubs whose very prickly leaves make it quite certain that it will not be left unnoticed.

EDWARD S. SIMPSON.

BOYA.—SEPTEMBER 3, 1910. LEADER, DR. FRANK TRATMAN

On September 3 the fortnightly excursion was to Boya, just beyond Greenmount, on the Smith's Mill line, a particularly favorable place for such a purpose, as it is not much known to the general public. There were present as visitors Professor T. W. E. David, of Sydney, Dr. Danes, of Prague University, and Mr. Grant Watson, an entomologist attached to the Cambridge Ethnological Expedition. Other visitors and a good number of members made up an enthusiastic party.

BOTANY. The season is as yet somewhat early for the botanist, but some interesting specimens were found. Among orchids:—*Caladenia filamentosa*. Individual orchids in their growth are quite separate and distinct. This specimen shows two individual plants joined together above the bulbs with a third flowerless leaf in between. In this respect it is exceptional. *Diuris setacea*, showing two well-marked bulbs in contradistinction to its near neighbour *D. longifolia*, which has none. *Prassophyllum elatum*. The tallest plants of this genus found measured three feet Droseraceae. Members must have noticed very often a number of orchid leaves springing up which do not develop a flower for that year. I did not think that *Droseras* did the same thing, but the moist places at Boya were strewn plentifully with dark red eight-leaved *Drosera* rosettes. I do not believe they are scapeless plants, but flowering plants which have already flowered and faded down. *Drosera neesii* and *D. pallida*, both with their bulbs. Other fully developed plants found were *Hakea undulata*, *Tribonanthes longipetala* and *Isopogon roseus*.

GEOLOGY.—Mr. E. S. Simpson has supplied the following notes: There are two Government quarries on the sides of the Helena Valley within a few yards of Boya Siding. The eastern quarry, which is by far the larger ,supplied the granite blocks with which the two moles at Fremantle Harbour are clothed. The granite in this quarry appears to be identical with that at

Mahogany Creek—a microcline-oligoclase-biotite rock. In the section cut the felspars are very clouded and are therefore difficult to determine. Slight traces of gneissic structure are seen at times in this rock. A pegmatite vein in the quarry is composed largely of microcline. Veinlets of epidote are seen in places.

In the western quarry work has been concentrated on a dyke of quartz diorite, the rock being crushed for ballast. This dyke is interesting on account of the numerous schlieren in it. These are much coarser grained than the average rock and are composed largely of amphibole of two species, with which are associated large skeleton crystals of ilmenite. In the main mass of the dyke the latter mineral is represented by numerous large pseudomorphs of leucoxene.

GOSNELLS.—OCTOBER 1, 1910. LEADER, DR. C. G. THORP.

The excursion to Gosnells took place on October 1. There were fifteen members and their friends present and a very enjoyable afternoon was spent in spite of swamps, hills and heat. The geological party, of which I constituted myself one, unfortunately missed the mine which is in the locality, and will be visited the next time we go to Gosnells.

Dr. Tratman took charge of the botanical section, and reports as follows:—Gosnells is at any time of the year a good botanical hunting ground, but is especially so before the swamps at the foot of the hills have dried up. The following is a list of plants in full bloom on this date.:—*Microtis parviflora, Glossodia emarginata, Thelymitra crinita, T. villosa, Diuris setacea, Calythrix glutinosa, Andersonia latifolia, Melaleuca scabra, Verticordia insignis, Conothalmnus trinervis, Microcorys longifolia, Utricularia hookeri, Stylidium carnosum, Thomasia glutinosa, T. montana.*

Mr. Giles, who had charge of the entomological section, has furnished me with the following particulars:—The entomological results were hardly worth the time expended in the search, especially so if one considers the extent of ground covered during the afternoon. With the exception of the common "Painted Lady" butterfly (*Pyrameis cardui, var. kershawi*), no Lepidoptera were observed, but we found a few of the nut-like cocoons of a species of *Limacodes* moth, not previously taken in the State. This we are in hopes of hatching out later on, then if success favours us we shall be glad to exhibit them at a future meeting of the Society. A few scarce but known Coleoptera were captured. Owing to the unfavourable weather conditions, none of the other orders were taken.

GEOLOGY.—Mr. E. S. Simpson has supplied the following notes on geological features:—The Gosnells railway station is on the outcrop of the Guildford shales of Mesozoic age, lying at the foot of the Darling Ranges and having a very slight dip to the west. The escarpment of the range here as elsewhere in the district is composed of granite, somewhat gneissic in places. A very conspicuous feature is the large white quartz reefs which are so numerous to the north-east of the township as to make one spur appear distinctly white from a distance of several miles. These reefs contain only traces of gold. Further north than the party ventured a tunnel has been driven into the side of the hill a distance of 180 ft. to test the value of one of these reefs in the sulphide zone. The quartz was found to carry a little iron and copper pyrites, the gold contents of several samples being either *nil*, or a trace. (*Vide* Report of the Department of Mines for 1909, page 123).

WEST GUILDFORD.—October 15, 1910.

Leader, Mr. Catton Grasby.

On Saturday, October 15, the members of the Natural History and Science Society visited the chemical and superphosphate works recently erected at West Guildford by Messrs. Cuming, Smith and Co., Ltd. The visitors were shown over the buildings by Messrs. Perry and Garnsworthy, and two hours proved too short in which to inspect the very extensive and complete and interesting establishment, which includes five distinct chemical manufactories, besides one of the most complete power plants in the State, laboratory, fitting shop, and so forth. Perhaps the greatest interest was shown in the finely-equipped building, devoted to the manufacture of pure sulphuric acid from sulphur by the contact process, which is one of the most remarkable developments of modern technical knowledge.

Sulphuric acid is described by Professor R. K. Duncan, in his "Chemistry of Commerce," as "the king of chemical products," and the total consumption for the year 1904 exceeded eight billion pounds. When sulphur is burned the fumes consist of one part of sulphur, combined with two parts of oxygen. This is sulphur dioxide. To make sulphuric acid it is necessary to combine one more part of oxygen from the air with the sulphur dioxide, and then the addition of water gives sulphuric acid. It is the combination of the third atom of sulphur which gives trouble, and the marvel of the contact process is in the fact that when the sulphur fumes and air after being freed from all impurities are passed through a column containing about £1,000 worth of prepared platinum, at a temperature of from 400 to 500 Cent., the catalytic action of the platinum causes the necessary oxygen to combine with the sulphur fumes without itself being changed in any way.

Catalysis is one of the greatest secret wonders of modern science. The visitors lingered long discussing this particular application of it, which cost German investigators many years of patient labour, scores of disappointments, and enormous sums of money to perfect. Messrs. Cuming, Smith and Co., Ltd., hold the sole patent rights for Australasia.

Only slightly less interesting were the buildings devoted to the manufacture of sulphuric acid by the old chamber process. Here the pyrites ore from Murrin Murrin is roasted in huge cylindrical retorts, the sulphur fumes are purified from dust, and then passed through a series of huge leaden chambers, where they are brought in contact with currents of air and steam in the presence of nitric acid fumes, which act as a catalytic agent, and cause the sulphur dioxide to take up more oxygen, and with the steam form low strength sulphuric acid, suitable for making superphosphate. Over 200 tons of sheet lead have been used in the construction of the chambers.

In other buildings the process of manufacture of nitric acid from nitrate of soda and sulphuric acid, and of hydrochloric acid from common salt and sulphuric acid were watched with interest after which Mr. Perry explained the method by which phosphatic rock is transformed to superphosphate, and was accorded a hearty vote of thanks.

BOYA.—OCTOBER 29, 1910. LEADER, MR. H. M. GILES.

Saturday afternoon, October 29, was the date appointed for visiting this locality, and we are glad to report that upwards of twenty members assembled at Perth Railway Station to proceed to the scene of operations by the 1.30 train. Contrary to a rule, some might expect, perhaps, many of the members were observed to be much heavier laden on the outward than the homeward journey, especially was this the case with our President, as on reaching the hill it called for a more even distribution of labour towards the spot chosen for our search for spoils. On reaching the quarries a halt was called and the loads deposited in the smith's shop, while members explored their surroundings in search of treasures in their respective branches; but I am sorry to say that very scanty success attended any but the botanists' section. The district has not recovered from the disastrous fires of a year or two previous to be of any use to the entomologists, and it will be several more ere it will be productive of much to interest them. This used to be a very fair collecting ground some few years back, but it is doubtful indeed whether many insects which were common here may not have been almost exterminated..

The botanists were favoured with a fairly good harvest, as is usual for this locality, but as Dr. Tratman has kindly promised a few notes concerning it, it is only fair to leave what he has to tell us concerning his pet subject, as I am sure he will do it much better than I shall.

I did not hear if our President or Mr. Simpson made any rich mineral or geological discovery then, but I am sure they will be only too pleased to let us share it if they did

At half-past four we again met at the smith's shop to partake of the cup that refreshes of an afternoon and pack up, but perhaps "pack in" will convey a more intelligent reason why some members returned so much lighter laden than on going. After which we worked our way to the railway siding to return. If Mr. Lee, the appointed leader on this occasion, had heard the many regrets at his not putting in an appearance this afternoon, I am sure he won't do it again, if only to relieve me of the task of furnishing this not quite so satisfactory report as we could have hoped for.

H. M. GILES.

CANNINGTON.—NOVEMBER 26, 1910.

On Saturday, November 26, the botanical section of the Natural History and Science Society made an excursion to Cannington. Unfortunately, the party was without a scientific leader, but Mr. Giles kindly pointed out a part of the scrub where rich finds had been made on a previous occasion.

Many *Eucalyptus* trees were noticed to be thickly in bloom and *Banksia* flowers were also conspicuous. After securing specimens of *Leschenaultia*, *Goodenia*, *Candollea*, *Verticordia*, *Pimelea*, and a few orchids, it was decided to explore the railway reserve, where the soil was damper and where flowers were more abundant. Here the curious *Byblis gigantea* attracted attention, with its foliage glistening in the sunshine. Sedges, reeds and other water-loving plants were noticed in the hollows. The small-flowered blue *Leschenaultia biloba* was greatly admired. Good specimens of many other flowers were obtained, among them some fine *Anigozanthus* (two varieties), a *humulis* and *viridus*.

Journal of the Natural History and Science Society
of Western Australia.

Some Avenues for Research open to Natural History Students in Western Australia.

BY EDWARD S. SIMPSON, B.E., F.C.S.

(*Read 14th December, 1909.*)

This paper has been written in order to draw attention to one or two little-touched fields for research which have come under my notice, and in order that, by discussion, other equally promising fields may be made known to those of our members who have sufficient time and interest to explore them.

Foraminifera, Porifera (sponges) and Diatoms are in their fossil and living forms very abundant in the South-West and Eucla Divisions of this State. Whilst primarily within the province of the biologist, these organisms concern the geologist by virtue of the fact that important sedimentary beds are built up of their mineral skeletons, and by the light which they shed upon the age of the strata with which they are associated. Material can be collected in abundance within a few miles of Perth and further material from more distant areas is easily to be obtained.

SPONGES. -It is common knowledge that living sponges occur freely round our coasts, and some few of these have been named by European scientists. It is not, however, these that I had in mind in preparing this paper, but the fossil sponges, the siliceous spicules of which are so well preserved in several localities. None of these had been described in detail until the present year, when a fragment of spicular earth from Princess Royal, near Norseman, was submitted to Dr. G. J. Hinde, F.R.S., of Croydon, England, for description. In this small fragment Dr. Hinde found twenty known genera represented, besides other sponges still unclassified. The results of his work are being published by the Geological Survey of W.A.*

A sandstone from Mt. Barker has yielded numerous spicules, which constitute about two per cent. of the whole rock. Though this may be of the same geological age as the Norseman earth, most of the species in it are quite different. They have never been critically examined.

At Cape Riche, east of Albany, there is a bed of so-called sandstone, which is very tough and which is composed almost

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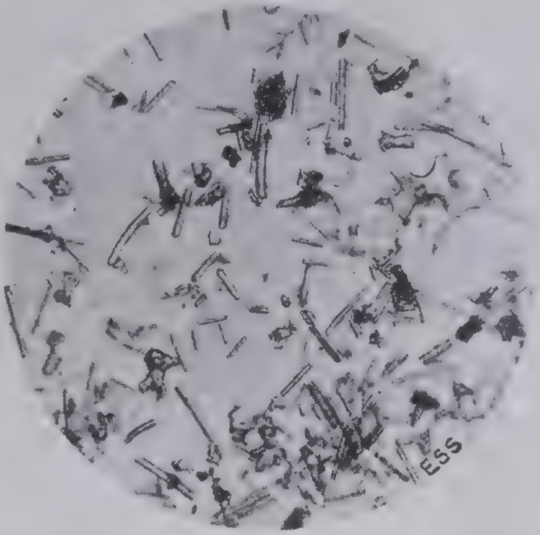
* G.S.W.A. Bull. 36, p. 7.



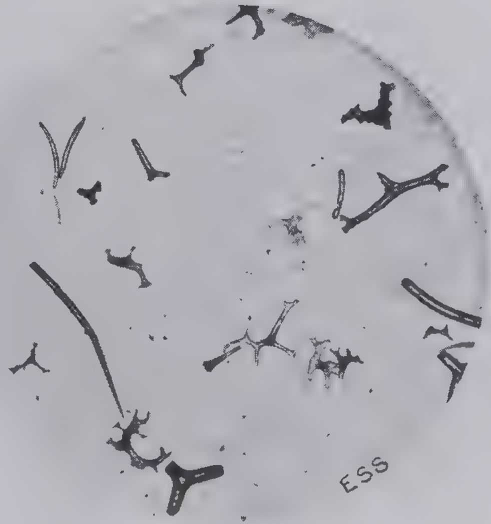


Fig. 1—Spicular Earth, Princess Royal, Norseman. X 40.

Fig. 2—Sponge Spicules from Sandstone, Mount Barker. X. 20.

[Photos by E. S. Simpson.[

wholly of sponge spicules. An analysis made of this rock showed its composition to be :—

Silica soluble in 5 per cent. NaHO	60.22
Silica insoluble in 5 per cent. NaHO ...	23.40
Alumina	6.25
Iron oxide	1.95
Lime	.13
Magnesia	.57
Water above 100°	2.74
Water below 100°	3.50
Alkalis and loss	1.24
	100.00

This stone resists fire well and has for many years been used by local residents for building bread ovens, etc.

The flats a few miles to the north of Albany are composed of an estuarine or littoral silt of Tertiary age, in which fossil sponges are common. Many large siliceous sponges have been found in two brick pits and loose spicules are plentiful in the silt.

FORAMINIFERA.—Slightly more has been done in the direction of classifying our fossil foraminifera, though even here the sum and total of work done is insignificant in comparison with that remaining to be done. The Census of Fossil Foraminifera of Australia submitted by the Rev. W. Howchin to the Australasian Association in 1893 contains only three West Australian species, all of them from the Carboniferous of the Upper Irwin River. In 1895 these three species, all new, were described in detail, with drawings, in a paper read before the Royal Society of South Australia.* In Vol. XVI of the Proceedings of the Royal Society of Victoria there is an important paper by Mr. F. Chapman, giving a detailed description, with drawings, of twenty-three species of foraminifera, six of them new, washed from the interior of fossil shells of *Trigonia* and *Cucullaea* collected in the Greenough district.

Practically the only other available information is contained in Bulletin 27 of the Geological Survey in three articles, one by Mr. Chapman, of the Melbourne Museum, the second by Mr. R. Etheridge, Junr., of the Sydney Museum, and the last by Rev. W. Howchin, of Adelaide. Mr. Chapman described and figured five species washed from a soft sandstone associated with the coal seams at Collie. Mr. Etheridge gave a description and several figures of a single species from the Carboniferous of the Upper Irwin. Mr. Howchin recorded details of thirty-seven species washed from the Gingin chalk.

The mudstones underlying Perth, samples of which are frequently brought to the surface by boring, would certainly yield many species. One species was also observed in the stone from Mt. Barker, which carries sponge spicules. The Post-Tertiary limestones so strongly developed all along the south-west coast from Geraldton to Albany are composed very largely of Foraminifera. The beach sands of the islands off Fremantle and adjacent parts of the coast are particularly rich in species of this order.

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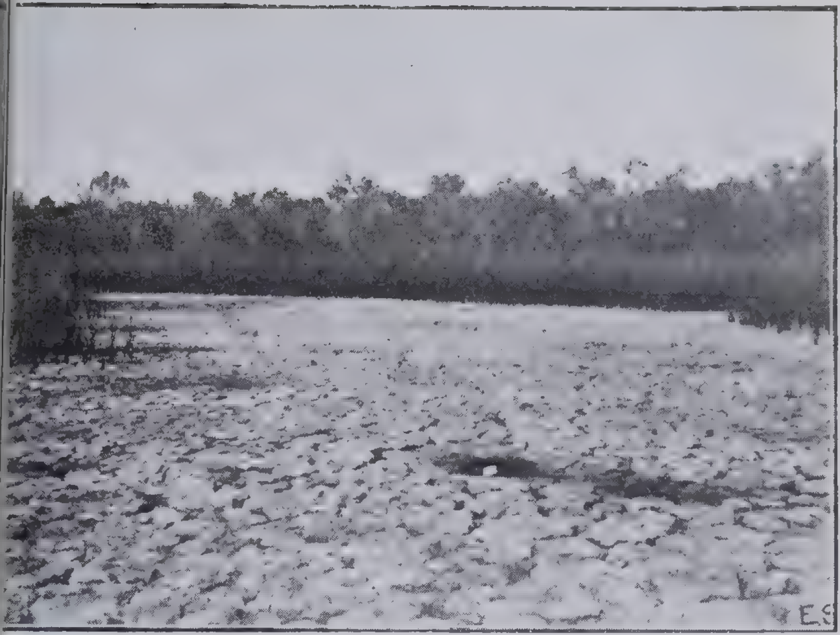
* Traus. R.S. of S.A., Vol. XIX, Part 2.

Diatoms.—Diatom frustules are composed of hydrous silica (opal), a substance which is very resistant to the attacks of air and water. For this reason the frustules tend to collect in beds wherever diatoms are growing. They are exceedingly abundant in the vicinity of Perth, particularly at Wanneroo and Jandakot, where their remains form beds several feet in thickness in many swamps and lakes. Some of these deposits have been examined by myself from a geological and chemical standpoint, details being given in the Annual Report of the Geological Survey for 1903. So far as I am aware none of the numerous species in the State have been classified.

The Wanneroo deposits are all apparently still in process of formation. The surrounding land is drift sand and the waters of the swamps, presumably on this account, are rich in silica and so favourable to the growth of diatoms. These grow in countless millions in the water, and their cell walls, together with a considerable proportion of organic matter derived from the protoplasm of the plants, accumulate in beds under it. It is only when the water has evaporated in the summer that the beds can be examined, and I have found the month of March the best for this purpose. At that season of the year, except after an unusually wet winter, Lakes Joondalup, Mariginiup, Jandabup, Little Badgerup, and Gnangara are almost wholly free from surface water, thus permitting a close examination of the diatomaceous earth which fills them to a depth of several feet. Where this material is perfectly dry the organic matter in it is very inflammable and is readily ignited by a bush fire. Once alight it will smoulder for months giving off a somewhat rank and very distinctive reek very like that of Irish peat.

A little caution is necessary in examining these beds. When burnt and unwetted, the earth sometimes loses all cohesion and any attempt to walk on it would result in sinking to one's knees or deeper in fine powdery dust at the bottom of which the earth may still be red hot and burning. When dry and unburnt, the earth is tough and will support almost any weight, it is then usually pale grey in colour and very light. On different swamps its appearance may be quite different under such conditions. For example, on Lake Mariginiup it dries in thin curled up flakes, on Little Badgerup in massive roughly regular polyhedra. When partly dry the earth is usually black or dark brown in colour and of the consistency of thick jelly. It will then just bear with safety the weight of an ordinary person. When thoroughly wet it forms a most treacherous bog into which cattle sink without hope of withdrawing and which is equally dangerous to any



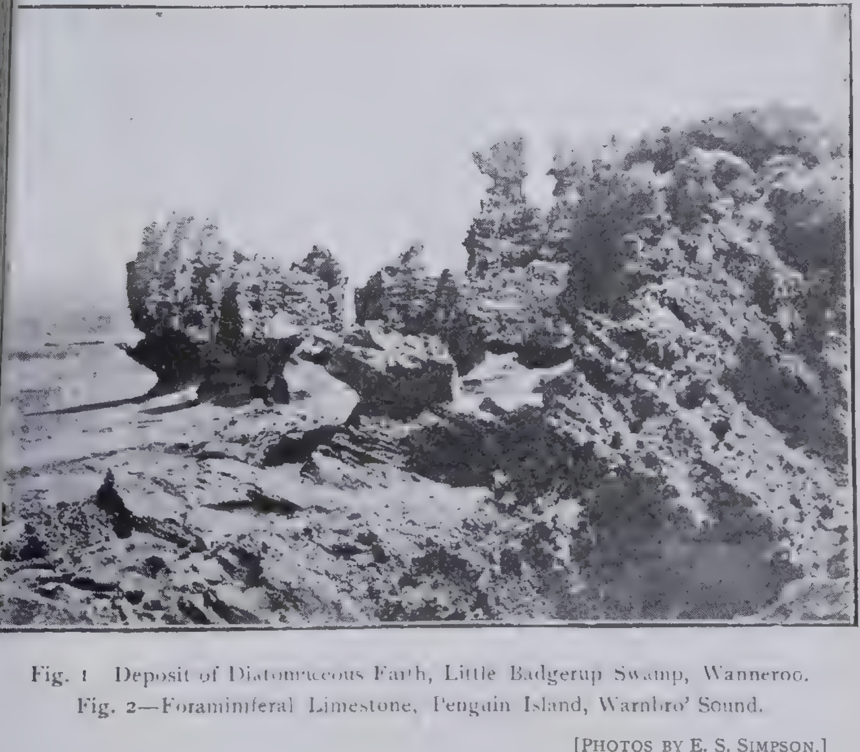


Fig. 1 Deposit of Diatomaceous Earth, Little Badgerup Swamp, Wanneroo.

Fig. 2—Foraminiferal Limestone, Penguin Island, Warnbro' Sound.

[PHOTOS BY E. S. SIMPSON.]

person foolish enough to tread upon it.

The species of diatoms in closely situated swamps varies considerably. In any one of them from ten to thirty different species may be recognised. A point which needs elucidation is the exact conditions which lead to these immense accumulations of such minute objects. I have noticed in many cases that the deposits are thickest at the northern ends of the lakes. One side of Lake Joondalup is formed of the coastal limestone, which probably accounts for the diatomaceous earth in this deposit being contaminated with shell fragments and calcareous mud. In 1903 the whole of the north-western portion of it was burning steadily down to a depth of several feet. A white moss-like growth of a *Chara* covers a large part of this deposit.

Thompson Lake and Bibra Lake, at Jandakot, to the south of Fremantle, are, like the Wanneroo swamps, filled with diatomite. They are for the most part dry during the latter part of the summer.

Similar deposits exist further south. A large stretch of swampy country to the south of Grasmere, near Albany, has been drained recently and put under cultivation. A very pure diatomaceous earth covers the greater part of it to a depth of several feet, and as at Wanneroo makes an excellent soil for market gardens, because of the large amount of nitrogenous organic matter associated with the siliceous diatom frustules. Similar material has also been sent to me from the vicinity of Busselton, and from Cape Arid, between Albany and Esperance. It should be sought for in any swamp in the south-west where the surrounding soil is sandy.

Diatomaceous deposits occur under rather different conditions in the Irwin River valley, east of Dongara. This country is largely occupied by the so-called "sand plains" in reality not plains at all, but rolling moorland, the soil of which is composed principally of coarse sand derived from the locally developed soft sandstones and grits of Carboniferous and later age. This country is for the most part very dry, but is dotted with oases where the scrub gives way to larger and more luxuriant vegetation. Within these oases the ground is constantly kept moist by subsurface springs of water, rich in silica derived from the sandstones through which it has filtered. Under these conditions diatoms grow abundantly (associated more or less with fresh water sponges) and form deposits of diatom earth at times several feet in thickness and covering many acres of ground. Many of the diatoms in these deposits are quite distinct from those in the south-western districts. Mingenew Spring and Irwin Spring are typical localities. The deposit at the latter point caught fire early in 1902 and burnt steadily for something like six months, much to the astonishment of local residents. In burning it gave rise to thick sublimates of ammonium chloride.

Cross-Breeding of Maize and the Mendelian Theory.

BY G. A. PFISTER.

(Read 11th January, 1910.)

In September last Mr. Andrews told you in his lecture on Mendelism what the foundations of this marvellous science are. He told you who Gregor Mendel was, how he discovered the principles of segregation, and how his discovery now enables experimenters to work systematically and with a practical certainty of the results.

Permit me, however, to shortly revise the most important fact of Mendel's Principle of Heredity. In the production of a new individual the essential feature is the union of two germ cells —in plants the ovule cell and the pollen cell. In the first generation we will have individuals, which in the case of cross-breeding will carry the character of both parents, although they may not be evident ; furthermore, these characters will not be represented in equal proportions, but one will be dominant, the other recessive. The F (filial) generation shows plants of great variety, some bearing the characters of one parent, some of the other, some a new appearance. Upon examining and classifying these plants, in three-quarters of them we find the character of one parent prevalent the dominant while the other quarter consists of plants showing the characters of the other parent—the recessive. In the F 3 (3rd filial) generation the Recessive F 2 (2nd filial) form only Recessives and can be called pure recessives. The F 2 Dominant, however, produce Dominant pure, and two-thirds impure dominants.

Mendel, and those who re-discovered his theory and completed it, have established a number of laws, which govern the production of new individuals. The case which I intend to put before you to-night is one of cross-breeding maize, with the intention of securing a plant which was suited for ensilage purposes, the chief requisites being abundance of foliage, a great number of corn cobs to each plant, and early development of the plant. The objection will be made that maize is not a suitable plant for experiments on Mendelism, on account of its not having self-fertilizing flowers, but distinct male and female flowers. This makes it also comparatively difficult to secure perfectly pure parents. The parent plants, however, were bred from seed which had proved constant through many a generation, and fertilization took place in separate rooms, where there was no possibility of casual pollination through wind, by other maize plants.

I chose as parents the following varieties :—

1. White American Horsetooth (tall, single-stalked, long leaf, white seed, late variety) W.H.
2. Ninety Days' Maize (medium height, medium leaf, yellow seed, very early) N.D.
3. Peruvian Maize (medium height, long leaf, dark brown seed, very prolific bearer, rather late variety) P.M.

The first crosses were made between W.H. and N.D., and W.H. and P.M. In both cases the W.H. proved the dominant, the other varieties being recessive.

1st Hybridization.

P (parental) WH x ND

I

F1 (1st filial) WHND

F2 (2nd filial) WH WHND NDWH ND

Dominant Recessive

The F1 generation proved to be a variety of medium height, long leaf, white seed, and early ripening.

Of the F2 generation the WHND was the variety which gave the best promise, being tall, very early, having long leaves and a pale yellow seed.

2nd Hybridization.

P WH x PM

F WH WHPM PMWH PM

Dominant Recessive

The second F1 generation was of medium height, long leaf, a prolific bearer and produced white seeds rather late.

Of the F2 generation I considered the P.M., W.H. the most suitable. Medium height, long leaf, very prolific (in some cases five cobs to one single-stalked plant). The seeds, which ripened rather late, were of blue-grey colour.

To obtain an early cross-bred P.M., W.H. I could have crossed it with N.D. variety, but, considering the advantages which the cross-bred W.H.,N.D. had over the pure N.D. maize as an ensilage plant, I decided to cross the two hybrids.

P WHND x PMWH

F WHND WH ND PM WH PM WH WH ND PM WH

Dominant Recessive

Naturally, all the hybrids contained the W.H. strain. The P.M., W.H., W.H., N.D. proved to be the plant which I desired. The F1 generation consisted of tall single-stalked plants, with long leaves and bearing numerous cobs, which ripened fairly early, showing white, blue-grey, yellow, and brown seeds. There were in the F2 generation a number of plants which from the predominance of colour and form of the seed and the form of the leaf I judged to be the P.M. W.H. W.H.N.D. ; further breeding showed that my supposition was correct.

The new characteristic of this hybrid was that it stooled out like millet, producing a much greater amount of green fodder than the single-stalked plants hitherto obtained. The plant is fairly tall, and the seed ripens early. The cobs contain grains of the colours mentioned in the F1 generation, white being predominant, blue-grey numerous, while the brown and yellow seeds are very scarce. The colour of the seed has also a distinct numeric proportion. I counted the differently coloured grains of 60 cobs, and found that about 75 per cent. of the grains are white, and 25 per cent. dark. The extremes were —

427 white to 109 dark
273 white to 74 dark

This shows that the white is dominant while the dark is recessive, and this is in accordance with the other characteristics of the new hybrid. It, however, does not matter what colour the seeds are, the dark and white seeds alike producing similar plants.

This hybrid, however, does not breed true, inasmuch as there occur specimens which are typical P.M., that is plants of medium height, long leaf, and brown seed, ripening late. At present I am trying to eliminate this occurrence. In 1906 I raised the first crop of this final hybrid in Western Australia on swamp ground near Pinjarrah, and in 1907 Mr. Berthoud, manager of the Experimental Farm at Hamel, W.A., grew some of it, finding it very good and naming it " Pfister's Pearl Maize." From Hamel the seed found its way to several farms in the South-West, and is now met with in different places.

In 1909 I cultivated some of this maize at Niagara, 500 miles east of Perth, in a very hot and dry climate, artificial watering being a necessity. And here a new phenomenon occurred which so far I am unable to explain satisfactorily. Of twenty plants which I cultivated, six stooled out bearing male and female flowers, thirteen produced only one stalk bearing only the male flower, one produced only one stalk bearing only the female flower.

I doubt that here we are dealing with a case which can be explained by Mendelian methods. To my knowledge there is no precedent of any maize having separate male and female plants, nor do I know of any plant of the same class or family behaving in this way. I believe rather that we have to deal with plants which developed abnormally in consequence of the sudden high temperature (114 in the shade), which caused the male flower to develop earlier ; in fact, of plants which I examined closely I succeeded in detecting embryonic flowers, about a quarter of an inch long (while the female flower was in full bloom) in four plants, while the others showed no sign of any female flowers whatever. Fortunately, I have seeds from the same cob left and as soon as I am transferred to some district where conditions for maize-growing are more favourable than in Niagara, it will be possible to ascertain to what degree the climate was responsible for the unusual occurrence.

I have given you the result of my experiments, and as you see, the Mendelian principle proved to be correct in these instances. At present I am experimenting with two plants which promise highly interesting as well as striking results. I mean the beautiful Sturt's Pea (*Clianthus Dampieri*), which grows on the goldfields and the Lupine, which, although imported, is found wild in the South-West portion and some northern parts of this State. Though closely related, and somewhat similar of leaf, the first is procumbent, and has scarlet flowers, the second is erect also bears blue flowers. Should my experiments prove successful, I shall publish them.

This brings my communication to an end. But I desire to put before you for consideration the application of Mendelism to human beings. Malformations and certain diseases have been used as examples. It is obvious that it is very difficult to obtain reliable information concerning a sufficient number of generations, and, therefore, it is very difficult to ascertain whether or not the Mendelian theory applies to human beings. But, quite apart from this, it seems to me that there is one reason why even correct genealogical records stating the cases of heredity in a sufficient number of generations have little value.

In experimenting with plants, we obtain mostly, if not always, the fertilization of all the ovules contained in the seed-case. In other words, the flowers bear seeds to their utmost capacity. In working out the proportions between Dominant and Recessives, pures and impures, we have a solid foundation upon which we can base our calculations. In the case of men this is practically never so. No woman can be said to bear the highest possible number of children. If, therefore, we have in human progeny the proportion between Recessive and Dominant which does, or does not, agree with Mendelian laws, the question will always be open. What would have been the case if further children had been born? Would they have upset or re-adjusted the proportion according to Mendel's principles. And as this question necessarily must remain unanswered it seems to me that experiments and records in this direction will always be of little value.

The Need for an Ethnological Survey of Western Australia.

BY W. D. CAMPBELL,
A.K.C., F.G.S., A.M.I.C.E., L.S.

(Read 11th January, 1910.)

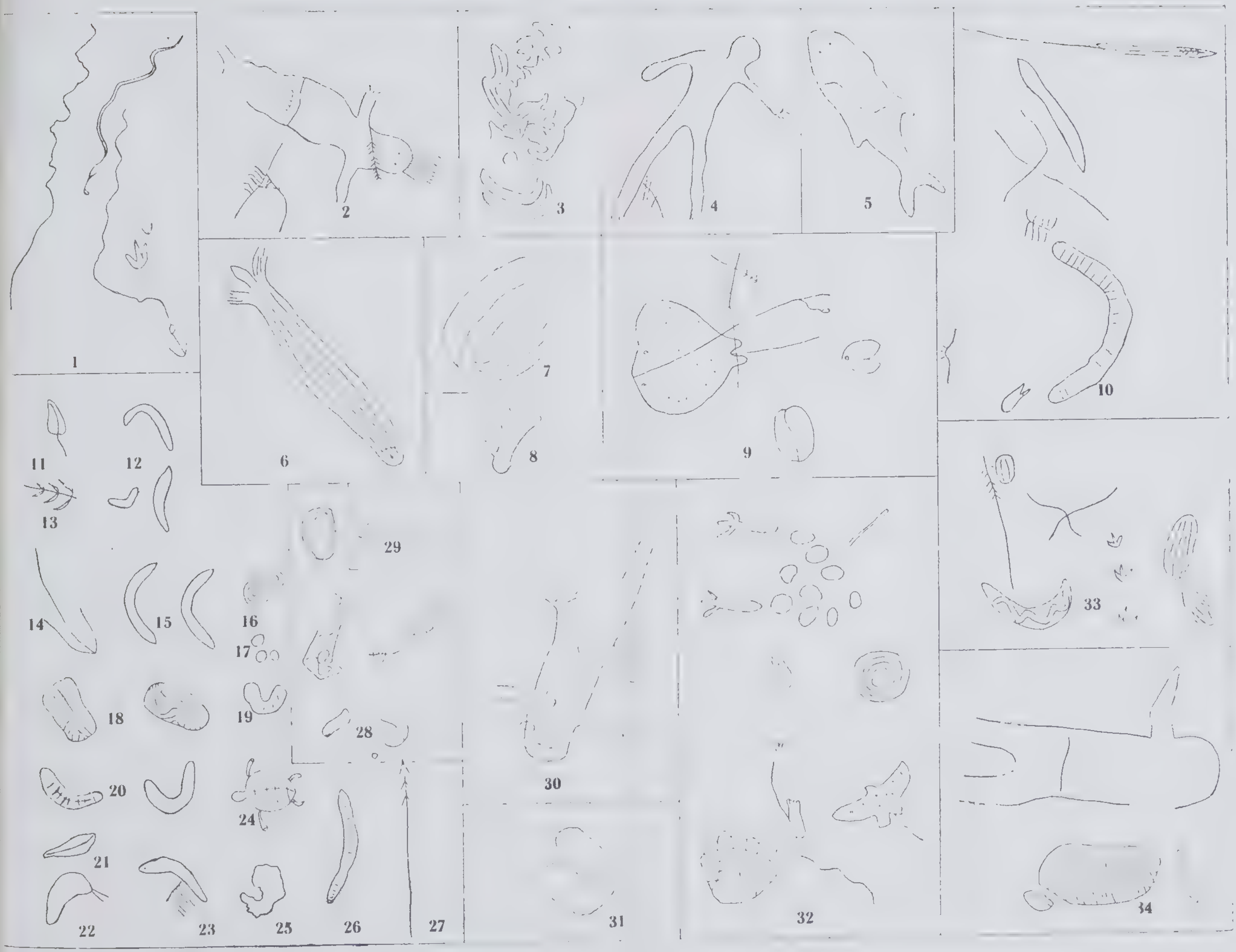
The following two papers on aboriginal subjects are brought before the Society as illustrating the work that would be embraced by an Ethnological Survey of the State, which the writer submits should be undertaken now, either by the Government, or, failing that, by some scientific body or bodies assisted by a Government subsidy, if possible.

It would constitute an extension of the work that has been begun under the direction of Mr. Malcolm A. C. Fraser, the Government Statistician, and by Mrs. Daisy M. Bates, in an historical linguistic direction. It would have for its object the delineation to scale by means of drawings and photographs of all rock carvings, paintings and drawings, and recording as much as possible of the characteristics, customs, and lore of the aboriginals. The opportunity still exists in the interior and northern portions of the State for the deciphering of the carvings, etc., during the lifetime of the aborigines, where their legendary lore is still intact and where their primitive life and customs are maintained. These conditions will cease to exist before long and also the very people themselves, as has been the case in most of the other portions of Australia, where the meaning of their carvings, etc., have only as yet been guessed at instead of their having been recorded before it was too late. This was the position when the writer carried out the delineation of the "Aboriginal Rock Carvings of Port Jackson and Broken Bay" (see Memoir forming Ethnological Series No. 1 of the Geological Survey of New South Wales, 1899).

(1) Description of some Rock Carvings at Port Hedland.

The limestone ridge which extends along the south boundary of the townsite of Port Hedland has a width of about three chains and the higher part is not more than about five feet above the high-water of spring tides. The middle part has a hard bare limestone surface and has afforded a convenient place for the carving of outlines of various figures and objects by the aborigines. On the northern boundary of the townsite there is another exposure of limestone and the writer has been informed that there also are carvings. Mention was made of the carvings, in a paper by Dr. Cleland and Mr. Giles on this district (see *Journal* No. 6, page 45, dated February 7th, 1909). It has two photographic

Vol. III. Plate II.



representations of carved figures, but not of any of those given herein.

The outlines, both old and modern, are cut on the smooth patches, which are mostly a few feet in extent only, so that they mostly form a disconnected series, but in several places are so crowded together that they may represent the ornamentation of a "bora" ground, or place where the more important ceremonials were conducted. The carvings commence at the western end about two chains from the railway survey level post marked X/I, which is about 13½ chains due south by scale from the intersection of Anderson and Wedge Streets (see plate I, which is adapted from the plans of the Survey and Public Works departments.) The drawings forming plate II were made by the writer during the stay of the steamer "Bullarra" at the port during a passage from Perth to Derby in 1908. The following is a brief list of the groups of figures:—

No. 1. Two fishing lines and hook, also another with a anchor-like fish-hook; also an emu foot-print.
Nos. 2, 30 and 34. These may possibly be deity figures.
No. 3. Several fishing lines and two kylies.
No. 4. A man.
No. 5. A shark.
No. 6. A seal.
Nos. 7, 22, 23, 25, 28. Unknown.
No. 8. A woman.
No. 9. A "skate" caught by a fishing line, also a spear. One of the two separate figures was stated by an aboriginal to be a phallic representation, as are possibly figures 19 and 31.
No. 10. Spear fitted to a womera, a kylie and a footprint.
Nos. 11 and 13. Leaves of a tree.
Nos. 12, 15, 16, 20, 29. Kylies.
No. 18. Two shields.
No. 24. Turtle.
No. 32. Emu nest and hunter's footprints, also a hawk and dilly bag.
No. 33. One spear and kylie, two shields and two emu footprints.

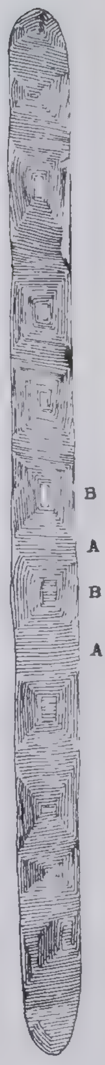
The railway has been laid out along the ridge and it will probably entail the destruction of most of these carvings, either directly or indirectly, so that it is desirable that as many of the figures may be recorded as possible for future reference.

(2) NOTES UPON THE ABORIGINAL DANCING BOARDS OF WESTERN AUSTRALIA.

The aboriginal tribes inhabiting the interior of Western Australia have some peculiarities in form of weapons, ornaments, and ceremonials differing from those of the coastal tribes. Among these specialities are what the writer has called "dancing boards," as they have not been previously described and they form the subject of this paper, which is an amplification of one contributed by the writer by invitation to the Royal Society of Tasmania in 1904. It was forgotten, however, to be published in their Proceedings through the failing health of their secretary, but it appeared in the *Tasmanian Mail* of the 12th August, 1905. The area concerned extends from the Yilgarn and Coolgardie Goldfields, on the south, to near the coast at the Pilbara Goldfield, to the northward, a distance of 700 miles, to the eastern boundary of the State and probably beyond it. As far as the writer has been able to ascertain, the use of the boards does not extend into the Kimberley district, which covers an additional area of 400 by 400 miles to the northward. The names used for these boards by the Bulong tribes is "Gundine," and by the Kurnalpi tribes "Gannery," and by those at Kalgoorlie "Oorloo-edna" and "Coondang" and "Ilma-oorloo."

The boards consist of flattish slabs of wood, ranging from 2 feet 6 inches to 13 feet in length, and 2 inches to 8 inches in width. They are always decorated on the flat or hollow side with incised patterns cut ordinarily by means of sharp-edged flakes of quartz; where, however, there is contact with white people the aboriginals are quick to avail themselves of the use of tools, such as steel tomahawks and gouges for the purpose The smaller sized boards are made of mulga wood, which forms the principal portion of the scrub in these localities, but as it does not often attain sufficient size for the largest boards, slabs of salmon gum (*Eucalyptus salmonophloia*) or white gum are used. The dead trunks of these trees weather and decay along the softer ring growths and gum partings, and white ants frequently eat out these softer ring growths, leaving shell-like portions of the outer parts of the trunk, affording thereby convenient slabs for this purpose. These are generally curved in cross-section, representing the curvature of the trunk of the tree, and even when the smaller slabs are flat a curvature is often artificially given to it by gouging out the most suitable side for the purpose.

Allied objects of symbolic import but of smaller size of both wood and stone have been described by Professor Baldwin Spencer and Mr. F. G. Gillen, in the account of the Horn Expedition in 1894 (see Vol. IV, pp. 76-80, and plate 7). The former states that they are common to a large group of natives in the interior, and to the Arunta tribe, and are called "Churina." "The typical form of the wooden objects is that of a slab of hard wood, which is either flat on both sides, plano-convex, or concavo-convex. The ends taper to more or less obtuse points, or are rounded. Many of them are in fact exaggerated forms of the well-known 'bull-roarer' (Trula), which itself must be regarded as belonging to the same category of articles. Both surfaces are marked with



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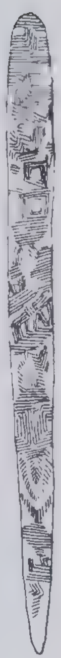

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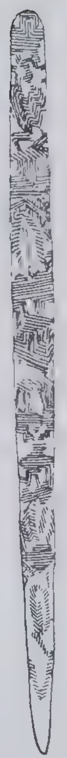

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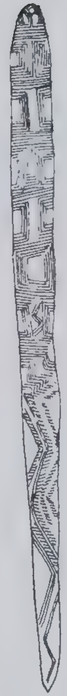

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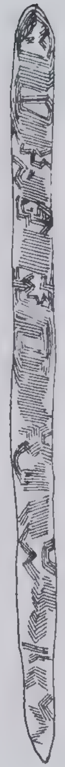

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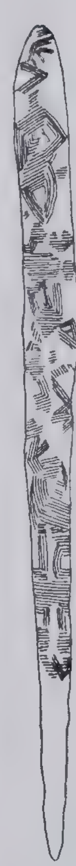

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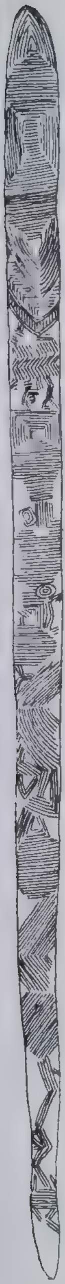

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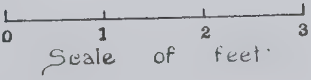

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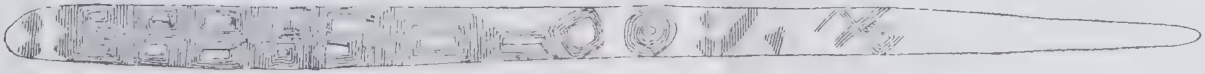
various patterns cut by the tooth of some small marsupial, such as Bettongia. Mulga (*Acacia aneura*) seems to be the hardwood used. The incised pattern consists, in the great majority of cases of a series or groups of concentric circles, half circular or larger or smaller arcs of bands made up of sinuous or straight lines or rows of dots; these various elements being usually combined to form the whole pattern. Some of the longest of them show abundant signs of having been smeared with blood and decorated with *Portulaca* down, and two or three bear the sinuous outlines of a snake incised along the whole length." On page 77 it is mentioned that the stone forms are most frequently of oval shape, and on page 80 he says the stone forms are the rarer and appear to stand in greater value and importance, though he believes their associations were of the same nature, and mentions that Mr. Schultze speaks of the markings as being understood only by the old man who had charge of the festival (in which they were used). Four to five feet appear to be the length of the larger of these objects met with in the Horn Expedition, but the larger boards of Western Australia are three times that size and are only decorated on one side, and the writer has not heard of any stone forms existing in Western Australia. The markings on the boards are more than mere ornamentation. The numbering alongside figure 1, plate 1, denotes the varieties of marking on that board; their names are (1) "Coondinnie," (2) "Cooru," (3) "Walga." The feathery markings on some of the other boards are called "Courra." The aboriginals only slightly divulged their meaning to the writer, but each "Coondinnie" pattern appears to represent a tribal centre, such as Southern Cross (Karrigiban) or Bardoc (Miandra), which has representatives or delegates at their initiation ceremonies. The Kalgoorlie aboriginals to whom the drawings of certain boards (No. 2 to 7) were shown by the writer, stated that they could not interpret them and said that they were very old and that the men who made them must have been dead a very long time, and they evidently regarded the designs with much awe. These boards, however, belonged to the neighbouring "Beiloon" tribes of the Kurnalpi district, about 40 miles distant, with whom they did not corrobboree.

The boards are prepared for the corrobboree by being daubed with white clay or kaolin, in bold transverse markings and scroll-like patterns, and the spaces between these are coloured with red ochre. These painted designs are quite independent of the incised designs. Figures 2 to 7 represent boards from Kurnalpi; these, excepting No. 2, comprise a set that was found and seized by Police-Corporal Bewsher in December, 1893, at a hill 1½ miles out north of Kurnalpi, under a mound of earth and scrub, which had an east and west direction. This mound was considered by him to be only a temporary place of concealment. Close to the east end was a small mound of stones, with one triangular stone laid on the top pointing to another hill. This he surmised was the direction of the permanent storage place of the boards, which Corporal Bewsher's companion, a miner of the name of Con. Bourke, had heard of as being situated about 100 miles distant, where it was said the boards were kept standing on end, in a semi-circle, with a kind of arbour over them, with paths swept clean leading to them. The blacks were hostile to any intrusion of its precincts. In Corporal Bewsher's case the unfortunate blacks discovered in a short time where the boards had been taken to, and watched the police station so persistently that the boards were sent away, those represented in figures Nos. 4 to 7 being given by Bewsher to the Western Australian Museum, and No. 3 to the postmaster at Kurnalpi, Mr. H. B. Loughrey, who sent it with another sample, No. 2, from the same district to the Post Office Club, at Coolgardie. He informed the writer that he had only obtained it after great persuasion and gifts of silver coins, and then only brought it on a suitable rainy night, so that the rain would obliterate his tracks, and it was brought to his office at about midnight, with an entreaty never to let a gin (woman) see it, saying that she would die if she saw one of them. This belief is general among them, and they evidently do not hesitate to keep it true, by knocking the unfortunate woman on the head. Nos. 1 and 10 to 14 were made for the author at his survey camp at Boulder, near Hannan's Lake, by some aboriginals, out of jarrah planking one inch thick, which he supplied to them for the purpose. The large one, figure 1, took four aboriginals the greater part of two days to make, working two at a time. The writer had gained their confidence during three years' residence on these goldfields, otherwise it would have been impossible to induce them to make them. This and other large boards which they made were not pointed like the older samples, but had both ends rounded. As a test to the truthfulness of their work the aboriginals were allowed to make, at their own request, one large board for themselves, and this one was also made with rounded ends and in a similar ornamentation, and it was carried away by them after dark with the greatest satisfaction. The whole work was carried on with an air of mystery and importance, and many were the hasty hidings up of their work when a distant sight of some of their women was obtained, but as a consequence of the writer's interest in their mysteries his camp and person were avoided by the females, so that there was no real probability of the women coming to the camp, but the anxiety evinced proved how intense was their desire for secrecy. When making the boards they sit on the ground and use the stone chisels or steel gouges in an adze-like manner, making the cutting stroke towards themselves.

Figures 8 and 9 in plate 2 represent boards that are in the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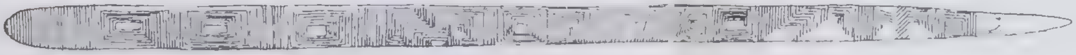
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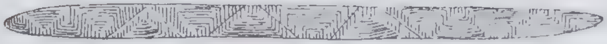

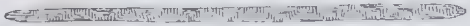
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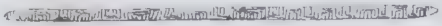
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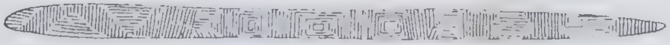
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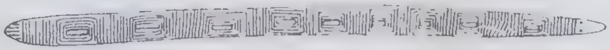
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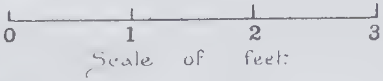

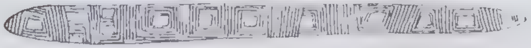
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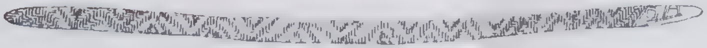
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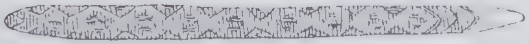

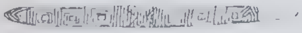
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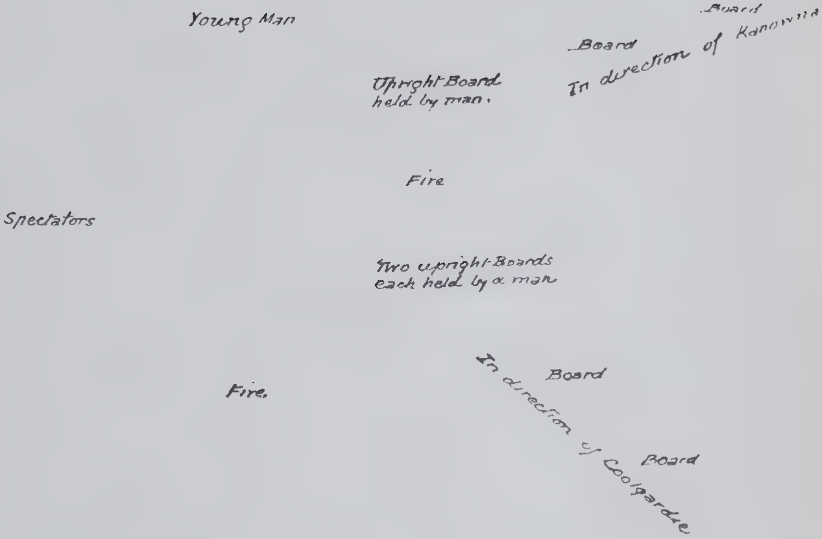
possession of the Rev. T. Saville, lately rector of St. John's Church of England, Kalgoorlie, who has since taken them to London. Figures 11 and 12 represent similar boards, but of smaller size. These are held one in each hand by the dancer who rests the tapered end on the ground. He then lowers and raises himself, making his legs tremble and his muscles quiver to an extraordinary extent, the attitude of the body being similar to that of the right-hand individual in figure 23. This art of trembling is largely used by all aboriginals here, and is intended apparently to exaggerate in a theatrical manner the appearance of great excitement. Figure No. 15 was found by Mr. W. F. Trencher, a post office official, hidden in a hollow tree near Mount Margaret, Murchison Goldfield. The tree had an exterior mark that had been made with a tomahawk, evidently for the purpose of identification. This board is now in the possession of Mr. E. Tunes, Telegraph Inspector, Coolgardie. Nos. 16, 17 and 18 are from Annean, Murchison Goldfields, and are in the Western Australian Museum, Perth. The sinuous patterns on Nos. 10 to 12 is used frequently also in the ornamentation of "womeras," implements that are used for spear-throwing. In respect to No. 10 a remarkable explanation was made by the aboriginal who made it. Commencing at the smaller end, he said that it was "the tail of one snake which went along" to the point where the pattern is doubled, "then little snake meet him, and then two fellow go along together till little one go down into hole, then one fellow snake go on." He said "coondang" is the name given to the "God-snake" and "nowarra" the name for an ordinary snake. The name "coondang" has already been mentioned as one of the names for a dancing board. Figure 14 evidently intended to be a representation of a snake, there being two eye-holes cut at one end. The pattern on figure 16 may be intended to represent this also. There seems, therefore, to be evidence here of the cult of snake worship, and it is probably combined with phallic or sex worship, for the boards may be symbols of the latter.

The aboriginals at Kalgoorlie informed the writer that their "doctors" are believed to have the power of flight in the air when they possess a "coondang" the power being exercised when the "doctor" is alone. This idea of flight is interesting, for it is possibly their method of representing clairvoyance. The subject is evidently one of their mysteries and the writer has not been able to glean any instances of its use, through having only a meagre acquaintance with their language. Another aboriginal stated that these boards represent a dark patch in the "Milky Way" in the firmament, the story being that "Father and mother walk about (travel) with little black boy, and by and by little fellow take them round, and stop one place, and no more seen. Mother stop in camp looking after tucker. Father follow him up, and find out that the boy had picked up a 'coondang' and taken it away." They had flown into the sky, and now form the dark patch in the brightest part of the sky (Milky Way). An account of the use of these boards was related to the writer by a very trustworthy aboriginal at Boulder, as follows:—When a young man is initiated, a board about 18 inches long is given to him and afterwards a longer one, and then one four feet, and then still longer boards. During the initiation the large boards are heated over a fire and are laid on the body of the young man, chiefly upon the chest and forehead, blistering the skin severely and taking the hair off. At ordinary corrobborees a break-wind or screen of scrub is made and the long boards are brought out after the women have covered up their heads or have gone away. The blacks then sing about its being so secret from women, and that the boards are not to be broken or burnt. The writer has seen several young men with freshly-healed burns of the character described, which evidently bore out the truthfulness of the account. The ordeal is probably a test of endurance. According to another aboriginal's account, "When a young man has completed his initiation he is given one of the smaller boards, and he hides it away as safely as he can and uses it as occasion may require at corroborees. When a tribe moves its headquarters the very long boards are taken to the new place in charge of some of the tribe, one or two days' journey ahead of the others, for the sake of privacy, for the long line of stragglers in the rear of a column would prevent secrecy being maintained regarding the boards." The use of the boards at a corroboree is thus described by another black: When there is a large corroboree many fires are lighted, and the boards are carried horizontally by two black fellows, each one holding an end, the boards behind being each several paces distant from each other, and they begin their dance at the most distant fire, passing in a winding course between the fires as they advance. Another way is for the dancer to hold the board upright behind him, the end resting on his waist belt, or else the board is thrust inside the belt and kept poised without being held while the posturing and trembling of the dancer is being made. Another arrangement of a corroboree at the Boulder is shown in figure 24. It was drawn for the writer by an aboriginal named Kangaroo.

The writer was unable to induce the aboriginals to produce their own articles of attire for the purpose of photographing them in dancing array, but after he had acquired the necessary articles some of them decorated themselves specially with them and exhibited several times the style of the dance (figures 19 to 21 are from photographs taken on these occasions, Nos. 1 and 2 showing the long boards carried horizontally each by two aborigines upon cross sticks. These are stuck into the belt or hair, or held in the hand or mouth, according to the fancy of the dancer. Figures 19 and 20 show the smaller boards only. The horizontal

VOL. III. FIG. 24.



NATIONAL MUSEUM MELBOURNE

board there shown is held tight by the waist belt, the central individual wears the "wani" or sacred head dress, which in form is like a radiating spider's web, from which it may be copied, but which possibly is intended to represent a halo (see also the nearer individual in figure 21). When constructing the "wani," a ring about 1½ inches thick is made of soft tops of scrub, and bound round with some bark or cloth, then seven or eight thin scraped and pointed sticks are stuck into it, in a radiating form, and the thread is wound in a spiral manner, a turn being taken round each stick crossing. The thread or web is made of the wool of opossums, kangaroos, or sheep, twisted between the fingers and rolled on the thigh by the palm of the hand. In the last-named figure the "wani" is surmounted by a rectangular shaped ornament of wool wound upon crossed sticks and placed upright in the hair of the head. The individual to the left-hand of the group holds a similar one in his mouth, and a tufted stick in both hands, and has other tufts above each ear and a smaller button-shaped one above the forehead.

Mr. C. G. Gibson, Assistant Geologist, found a set of six boards in a granite rock shelter at a soak at the foot of a hill about 60 miles north-east of Laverton in October, 1905. The four larger boards are now in the Melbourne Museum, and the two smallest, about four feet long, are in the possession of Mr. Glasscock, chemist, at Laverton.

In regard to the snake symbols, it may be useful to mention that in reply to an enquiry Mr. W. E. Roth, when Northern Protector of Aborigines of Queensland, informed the writer that "they were met with in the initiation ceremony north of the Endeavour River, between it and Princess Charlotte Bay. The whole ceremony ends with a huge representation of a snake curled round the lower branches of a tree. Snake symbols are met with carved on the two-handed swords of West Queensland. In the western districts also the powers of the medicine-men, etc., are believed to be learned from a supernatural water-snake."

The Origin, History, and Work of the Geological Survey of Western Australia

BY A. GIBB MAITLAND, Government Geologist.

(*Read May 10th, 1910.*)

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INTRODUCTION.

The forthcoming visit of the members of the Natural History and Science Society of Western Australia to the Geological Department affords an opportunity of prefacing it by a brief account of the origin, history and work of the Geological Survey, which really formed the nucleus around which the present Department of Mines and the Western Australian Museum sprang.

As is pretty well known to you all, the physical sciences are included under two main heads: Astronomy and Geology. The former includes all those branches of science which deal with the constitution, motions, relative positions, and mutual action of heavenly bodies, whilst the latter confines itself to the study of the one upon which we dwell, or, to put it briefly, Astronomy concerns itself with the whole visible universe, and Geology with the earth as an individual.

One of the most eminent of living geologists recently said:—
"perhaps the shortest definition that has been made of our science, and
"one equally acceptable to its students and to those who view it from the
"outside, is, that Geology is the *science of the structure of the earth.* It is
"in and around that earth structure that our geological ideas centre"

It has been found necessary for reasons which will be set forth at length during the course of the lecture, to establish a branch of the public service, which is charged with certain important geological investigations. Nearly every civilised country in the world has established a geological survey in some form or another, and the question is often not unnaturally asked, why does an efficient geological staff now form a necessary part of the machinery of government of all nations?

The ultimate object of any such survey is undoubtedly to promote the development of the natural resources of the country, and this can only be done by more or less systematic efforts to decipher the geological structure, and correctly interpret its history. In so far as a thorough appreciation of the peculiarities of mineral deposits are concerned, such can only be arrived at after a thorough understanding of their natural history; whilst in the search for new deposits and in defining the probable downward limits of those already known, geologists have to be guided to a large extent by a knowledge of how particular ore-bodies have been formed.

The fundamental object, therefore, of the geological survey of any country, when viewed from the scientific standpoint, is by a more or less systematic investigation of its structural geology, organic remains, and its mineral resources to arrive at a true understanding of its geological history.

These objects are carried out in a partially settled country such as our own by means of:—

(*a*) Reconnaissance surveys of those portions of the State about the structure and resources of which little is known;
(*b*) Detailed geological surveys of mining centres under active development, etc.;
(*c*) Chemical and mineralogical examinations of soils, rocks, minerals and natural waters collected by the field staff, and under certain specified conditions by prospectors and others;
(*d*) Palæontological investigations;
(*e*) The maintenance of a geological museum; and
(*f*) The publication of the data amassed.

HISTORY.

It may, perhaps, have been forgotten that the inception of active mining operations in Australia dates from the year 1842, when lead and copper mines were first discovered and worked at Waneranooka, in the Northampton district of Western Australia hence it is not surprising that this State was amongst one of the first to employ a geologist as part of the official staff.

The position seems to have been first occupied by Dr. Ferdinand van Sommer. This gentleman travelled extensively during the years 1847 to 1851 throughout the State. He geologically examined the Victoria, Toodyay, and York districts, and extended his observations to the country lying between the latter and Mount Barren, on the south coast. Neither the maps nor the reports of this observer appear to have ever been published, although three articles from his pen bearing upon the geology of Western Australia have appeared in the current literature during the years 1848 and 1849. The original drawings of Dr. van Sommers' maps have now been discovered, and are preserved by the Department along with that historical collection showing the progress of geological mapping in Western Australia, which is now on view in the Geological Gallery of the Museum.

After an interval of twenty-one years, during which much excellent geological work was accomplished by the Gregory Brothers, Mr. H. Y. Lyell Brown was appointed to the post of Government Geologist. This gentleman, during the years 1870 to 1873, prepared three geological maps and issued ten reports (now out of print), which referred principally to the Southern and Coastal portions of the State. One important map " Showing the Progress of the Geological Survey " on a scale of about 18 miles to the inch, indicates with a considerable amount of detail the geology of the coastline from Doubtful Bay to a little north of Geraldton. It is interesting to note that the first supply of artesian water in Western Australia was obtained in a bore near the Canning River, a few miles south-east of Perth, and close to the foot of the Darling Range, put down under the advice of Mr. Brown. His Excellency Governor Weld, in a despatch to the Earl of Carnarvon, dated 30th September, 1874, reported that :—
"it was with much regret that in 1872, owing to the disinclination evinced "by the Legislature in the then straitened circumstances of the Colony to "expend money on a scientific department, that I was obliged to forego my "desire of making it (a Geological Department), a permanent part of the "establishment."

In the same despatch the Governor, basing his information on the data contained in, and the deductions to be drawn from, Mr. Brown's reports, informed the British Government that :—
" the mineral riches of the Colony are very great I have never doubted "but that they would ultimately become a main source of its advancement. "All different kinds of auriferous quartz known in other colonies are abundantly found in various parts of this The question of payable gold is, as "I have long since reported, simply a question of time. . . . The Colony "is extraordinarily rich in lead, silver, copper, iron, plumbago, and many "other minerals are found in various localities, and indications of coal and "petroleum are not wanting—what is wanting is energy and enterprise to "develop these riches. . . ."

In 1882, nine years after Mr. Brown's retirement, Mr. E. T. Hardman, of the Geological Survey of Ireland, was appointed to the post of Government Geologist. His labours were chiefly confined to the Kimberley District, upon which he issued two voluminous reports illustrated by a series of geological maps. Mr. Hardman was the pioneer geological observer in the far north of Western Australia, and his field work carried out during the years 1882-84 laid the foundation of our knowledge of the geology of the Kimberley district, and played an important part in the opening up of the State's first declared goldfield. His two map and reports greatly stimulated prospecting as his predictions a to localities where gold would be found were afterwards justified Mr. Hardman on returning from the north examined the neighbourhood of Bunbury, Blackwood, etc., which ultimately resulted in the discovery of the Greenbushes tinfield. Later on he investigated the geology of the metropolitan area with reference to the question of its water-supply from underground sources. On the termination of Mr. Hardman's engagement with the Western Australian Government he returned to Ireland, and resumed his duties on the Geological Survey in 1885, bearing, I understand, the assurance that he would certainly be appointed if a permanent post of Government Geologist was created.

Mr. Hardman, to whom Western Australian geologists owe a debt of gratitude which it is difficult to repay, died after a few days' illness brought on by the inclemency of the weather and exposure to snow and rain, on the 30th of April, 1887.

"It is all the more sad to think that had he lived the long-desired post of "Government Geologist of Western Australia would have been offered to "Mr Hardman, the financial difficulties in the way of his appointment "having been removed just before he died"

Very shortly after Mr. Hardman's term of service in Western Australia came to an end, a motion was brought forward in the Legislative Council in 1885, having for its object: -

"the establishment of a permanent geological department for the Colony, "the geologist in charge of such department to combine with the duties of "his primary office those of public analyst."

The Hon. Member who moved the resolution stated that in doing so: -

"he trusted and believed he was moving in a matter that would do much "good to the Colony, and he *had confidence it would do no harm ! !*"

The same Hon. Member instanced the fact:—

"that the other Colonies had found that the value of the practical man "alone, without scientific knowledge to guide him, was not so great as the "value of the practical man assisted by the man of science, and these "Colonies were all forming geological departments the same as he proposed "to have established here"

The debate which followed the introduction of the motion is of considerable historical interest, as it indicates in a certain measure the status in which scientific men were held in the minds of some of the legislators in the colony at that time, though I cannot but suspect that it in some measure arose from a misunderstanding of the true functions of scientific research and that in many cases practical issues are often concealed when included in what appears to be a purely scientific report. One Hon. Member :—

"denied that scientific men had contributed in any way to the important "mineral discoveries which had made the fortunes of the other Colonies."

and further stated :—

"give him the practical man any day before all their scientific gentlemen"

A third speaker intimated that the State

"had already had some experience of these geological gentlemen, and for his "own part he had very much faith in what the Hon. Member for ——— said, "that we could not point to much good that they had ever done for the "Colony, and for his own part he would prefer to see the money spent in introducing practical miners, men with picks and shovels"

This gentleman was followed by another speaker whose view was that

"at present he had no faith in these scientific gentry at all—as a rule they "were like the newspapers, very wise after the event"

It is satisfactory to know that evolutionary processes have been steadily at work since that time, and that such views regarding the status of scientific research and its votaries no longer obtain save in the minds of those very few who invariably peer on the world through the narrow end of the telescope, and are unable to embrace more than microscopical ideas. Ultimately the motion to establish a geological department was defeated by a large majority, but, judging from the tenour of the debates, I am inclined to think that the question of ways and means weighed very heavily with the Hon. Members in arriving at that decision.

The late Rev. C. G. Nicolay in many ways contributed largely to our knowledge of the geology of the State and was in charge of the Geological Museum at Fremantle, founded by Mr. Hardman, which became ultimately merged into the National Museum.

It was not, however, until 1887, that the Government found itself able to provide the necessary funds for the post of Government Geologist. The appointment was conferred upon Mr. H. P. Woodward, who had previously served for more than three years under Mr. H. Y. Lyell Brown as the Assistant Government Geologist of South Australia. Mr. Woodward held the appointment of Government Geologist from 1888 to 1895. During Mr. Woodward's tenure of office he had for his associates Mr. B. H. Woodward, who acted as Curator of the Geological Museum and Assayer to the Department, whilst at a later date, 1894, Mr. S. Göczel was added to the staff as Field Geologist and Mining Engineer ; hence it became possible to divide the work and make a beginning on more or less systematic lines. It was during this period that the paramount necessity for :—

"the publication of reliable geological knowledge relating to the nature and "extent of useful mineral deposits supplemented by geological maps and "plans" *

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* Parl. Debates Leg. Council, Vol. 10, pp. 135 142. Perth : By Authority 1886.

and geological investigation of the important question of the underground water-supply of the Goldfields, was impressed upon the Government by its scientific advisers. The work of the Department during this period extended from Albany to Kimberley, though the issue of geological maps in illustration of the various reports seems to have been confined to the later years of the Survey. They include the Collie and Irwin coalfields, the tinfields of Greenbushes, the country between Nannine and Esperance Bay, Goongarrie, Cue, Yalgoo, and the Murchison Goldfields. In 1894 Mr. Woodward issued what is still perhaps the most recent geological map of the State; this was published in London, on the scale of 50 miles to an inch. At the date of its publication this map added very materially to our knowledge of the geology of the State, as far east as the 120th meridian. With such a limited staff, still more limited appropriation, the difficulties presented by the vast area of the State, and the practical absence of railway communication, the Survey, under Mr. Woodward, was able to issue twenty-one voluminous reports and six geological maps.

It will thus have been inferred from the above historical information that for some years before the establishment of the present department its need had been realised by many of the more intelligent people of the State, and that its origin was really inspired by a true appreciation of the value to the nation of its natural resources, upon the exploitation of which the welfare of the community so largely depends.

WORK.

The Geological Survey as at present constituted was created in 1896 for the purpose of the investigation of the geological structure, mineral resources, mining industries and underground water supplies of the State, and to this end it became necessary to prepare geological maps and reports such as might be used by the Government and the public in dealing with all general questions which arise from time to time. In such a country as this, the progress of which depends so much upon its mineral wealth, the Survey has, naturally, endeavoured to devote itself to the investigation of those problems in economic geology which it is essential should be solved—if that be possible, without, however, neglecting purely scientific questions; for, of course, the economic and scientific aspects cannot be readily separated.

It was pointed out to the Government that if the work of the staff was to be of that service to the country which the public had a right to expect, the officers of the Department should not be sent touring the State on every wild goose chase suggested or become parts of a mere prospecting machine, but so far as consistent with the resources available, an attempt should be made to carry out the operations as an organised whole. Should, of course, any important discovery be made, or new interests rise into prominence, about which it becomes necessary for the Government to have some early information, a member of the staff could always be instructed to make a special report thereon.

It will thus be seen that the Department was not established for the purpose of purely scientific research for its own sake, but with the hope that scientific investigation might be made of some material benefit to the proper utilisation of the State's natural resources.

In such an enormous country as Western Australia it is obviously impossible to carry on the field work even by making use of the most modern methods, in a strictly uniform manner, especially as financial considerations necessitate a staff somewhat limited in numbers.

In young, partially developed countries such as our own, there are two totally distinct classes of Geological Survey work necessary to meet public requirements. The first, is the detailed examination of the more important mining centres, which are under active development, the accumulation of information relating to the occurrence of the various ore deposits and their mode of formation. The second is the preliminary examination of comparatively unknown tracts of country with the view of ascertaining how far its geological characteristics are likely to affect its economic possibilities.

Theoretically, the latter class of work should, as far as possible, be carried out in advance of the occupation of the country for mining or other purposes. Investigation of this latter nature involves the tracing out of the distribution of the various formations that rise from beneath one another, and occupy the surface of the country, and representing these by means of a carefully designed scheme of colours on a map, on a scale sufficiently large to show all the geological and geographical details necessary. When viewed from the economic standpoint this is neither more nor less than a classification of the surface into parts, each of which may have useful minerals or other materials peculiar to itself. While, of course, such may be a true conception of what are theoretically the correct methods to employ, those of us who are charged with administrative duties are perfectly well aware that it is not what ought to be done, but what is possible to do with the resources at command, and the conditions prevailing at the time which govern the situation.

Whichever class of geological work is carried out it is invariably the case that it is in areas which have not been mapped with any approach to accuracy, and that maps suitable as a basis for geological or mining work are practically non-existent. If, of course, important geological surveys had to await the production of topographical maps, I am afraid that much of the work would have to be indefinitely postponed ; hence, in recruiting the members of the field staff, the officers selected have perforce to be familiar with all the usual operations of the engineer and surveyor. In other words, the field staff have to be men capable, if need be, of producing such topographical maps as are required to lay down their geological work, and correcting or adding to the topography of such maps as are available of the districts in which they happen to be at work. A good deal of the field work is carried out by a modification of the plane-table and stadia methods, which by doing away with the necessity for chaining, is sufficiently accurate for geological requirements, and, what is perhaps of greater importance, is that it is expeditious.

A topographical surveyor, Mr. H. W. B. Talbot, has now been included in the staff, and while adding materially to the value of the maps issued by the Survey, effects a considerable saving in the time of the field geologists. Topographical maps do a great deal to promote an exact knowledge of the country, and in this way, apart from their other multifarious economic uses, are, when intelligently used, capable of being made of considerable educational value.

The work of the department in its relation to *the mineral industry* is, of course, a complicated and delicate task, affecting as it does such a multitude of financial and practical interests. Legislative provision has been made whereby the members of the field staff have access to mines at all reasonable times.

Experience in most mineral fields of the globe has shown that many mining failures have been due rather to a want of knowledge of structural geology than from any lack of engineering training. Hence there has arisen the necessity for the detailed investigation of mines under active development. To this end geological plans and sections of mines have been from time to time prepared. These supply records of established facts in the disposition and changes in the country rock, the position of the ore-bodies, their productiveness under various conditions, and thus afford data otherwise unobtainable by which operations can be directed into the most useful channels. Detailed surveys on a large scale of many ore deposits have been made in the hope that they might in some measure furnish a guide as to the general behaviour of the lodes.

Prospecting, when it takes the form of the equipment of a party for the investigation of a particular tract of country, if it is to be intelligently undertaken, must be carried out in a rational manner. One of the first requisites for this purpose is a properly executed geological sketch map, which ought, amongst other things, to indicate those areas within which the strata possess economic potentialities. The knowledge thus acquired, when properly presented, tends to prevent the useless expenditure of time and money.

In the course of its work the Department has by means of reconnaissance surveys prepared several maps of fairly large areas for the purpose of meeting the demand for geological information of outside and lesser known mining districts, and directing prospecting into legitimate channels.

Surveys of this kind designed to serve a special purpose pretend of course to nothing more than broad generalised field work of a nature sufficient to furnish a sketch of the main geological outlines, the details of and scientific problems connected with which having, of course, to be deferred to an often remote future. The demands for such a class of geological investigation have increased somewhat more rapidly than can at present be met.

In relation to *the pastoral and agricultural industry*, the main importance centres upon the question of subterranean water supply, which is, without doubt, one of Western Australia's most valuable assets. If, of course, underground water supplies are to be intelligently sought for and utilised, it is quite clear that the first step must be the determination of their extent and character. In addition, the question of the permanence of present supplies and the extent to which such may be increased are, of course, of vital importance to the community.

Western Australia possesses a large tract of country in which artesian water has been found. It occurs in the following of those divisions into which the State is divided for administrative purposes, viz., the Eucla, South-Western, Western, and Kimberley Divisions. The area occupied by the artesian water-carrying beds have been defined with as near an approach to accuracy as the present condition of our knowledge admits, upon geological maps, which have been prepared after a more or less careful investigation of the structural geology of large tracts of country. Boring operations have demonstrated the accuracy of the geological deductions, and land that hitherto could not be made effective use of has been taken up and stocked, thus increasing the wool clip and the stock-carrying capacity of Western Australia.

Up to the present time observations in the *agricultural districts* have been confined to the mapping of the rock formations, which constitute the true subsoil, but as yet no attempt has ever been made to represent in detail the distribution of the superficial deposits upon which it is the function of the agriculturist to operate, and which constitute a great national asset.

The only fairly detailed geological map of an extensive area included within that portion of the State which embraces a larg extent of agricultural country is the one which extends from Northampton to Arrino. This map which was really prepared for the purpose of assisting in defining the limits of the Irwin River Coal Measures, by means of boring operations, shows *inter alia* the distribution of the various crystalline and superincumbent stratified rocks, as well as the alluvial deposits of the valleys and the blown sands along the coast. The geological map thus becomes of considerable value to those scientific cultivators of the soil who are capable of using and interpreting it with knowledge and with judgment; it, of course, makes no pretensions to defining the actual distribution of the soils, though it does represent what is immediately beneath them. In this way it affords a good basis upon which a map showing the distribution of the various classes of soils occurring in the district may be founded, though, of course, it is well-known that soil maps *alone* give but a very imperfect idea of the capabilities of land.

Attention has been merely drawn to this particular map because it affords an illustration of a class of work the Department has been carrying out, which when properly interpreted may be made of value to the agricultural industry, for the aid it affords in the direction of appraising the value of land, even though it was constructed for a totally different purpose.

In addition to the investigations carried out in connection with surface geology, the exploration of what may be called the subterranean geology of the State has been, perhaps unconsciously, recognised by the Government as being of scientific and practical importance, as may be seen by the policy adopted in connection with the use of its boring plants.

There are three distinct objects for which the boring plants have been usefully and actively employed as a direct aid to the development of the States' natural resources :—

(1) The search for artesian water in pastoral and other districts, and subterranean supplies elsewhere ;
(2) Proving the coal and oil-bearing formations ; and
(3) Testing the metalliferous deposits.

Many investigations are materially assisted by, and are to a large extent dependent upon, the results of such boring as has been carried out, when interpreted in the light of the local geological conditions, hence a good deal of work has been carried out by the Survey in connection therewith.

In addition to the duty of fixing the sites in which many of the Government or State-aided bores are put down, the geological work in connection with the boring consists in collecting as many records and cores as possible of all the bores put down in the State, and examining such of the cores as are available and interpreting the information they give in such a way as will render them of value to the public, etc., when embodied in the official reports.

In respect to pretty well all boring done by or with the assistance of the public funds, a fairly complete set of the cores now forms part of the Departmental Reference Collection ; whilst in the case of operations carried out at private expense, thanks to the cordial co-operation of many of the boring engineers, and to the ready response to requests for information, fairly complete bore records, which might otherwise have been lost, are filed in the archives of the Department.

Much, however, yet remains to be done before a really complete set of the journals of private bores has been collected, for there is no legal obligation on the part of the public to lodge such data with the Government, even though the operations may have been carried out on what is really State property. Unless some steps are taken to acquire the information there is a possibility that a vast amount of valuable geological data may be irretrievably lost.

PETROLOGY.

In addition to the field work to which your attention has just been directed, microscopic enquiry now forms an important part of the operations of the Department, for there are very many practical problems requiring special investigation in connection with the rocks of the auriferous formations.

The microscope has also to be employed in conjunction with the chemical balance, and both brought to bear on rocks, the relation of which to other rocks have been carefully investigated in the field. It may, perhaps, be of interest to you to indicate the mode in which the microscope is applied to the examination of minerals and rocks.

Slices cut by one of the many forms of the lapidary's wheels from the rocks or minerals are ground down smoothly until they are but a small fraction of an inch in thickness; they are then mounted on glass by Canada Balsam. The effect is to make the great majority of the ordinary constituents of rocks translucent if not transparent. They are then examined under a specially constructed microscope fitted with Nicol's prisms and other contrivances for optical tests. These refined optical tests often afford information leading to the discrimination of minerals where chemical analysis would not be available. When all the varieties of minerals occurring in a rock have been identified, one's work has only just begun, for its structure and history have to be investigated.

The mounted rock slides are properly registered and kept in a separate cabinet; a large number of slides have been accumulated, the collection amounting to about 1,400, and are ready for immediate reference at any time. The results of this microscopic work are embodied in the various official reports. Perhaps one of the most important petrological reports is from the pen of Mr. J. A. Thomson, B.A., B.Sc., F.G.S., which will be found in Bulletin No. 33. This gentleman's observations make by far the most noteworthy contribution to the petrology of the fundamental rocks of Western Australia which has yet been issued by the

Department, and will doubtless prove of more than mere local significance.

CHEMISTRY AND MINERALOGY.

A very necessary and important part of the organisation for carrying out the geological work which has been outlined is the Laboratory, in which such chemical, mineralogical, and other researches essential for the proper discharge of the duties of the Survey are performed. The laboratory is under the charge of a specially trained officer, Mr. Simpson, associated with a staff of assistants. By means of the laboratory considerable assistance is rendered to and the time of the field staff greatly economised, for it is upon field work that the time of the staff can always be most profitably employed.

To carry on the primary functions of the work in the laboratory certain plant and accommodation are, of course, essential, and this is of such a nature as may be utilised for making the necessary assays, etc., for the State Batteries, that it has been found best in the interests of economy and efficiency to have this work carried out by the Survey.

Part of the policy of the Government consists in the making of free assays and other determinations in the interests of *bona fide* prospectors, and most of this work is carried out in the Survey laboratory. This class of work naturally takes up a good deal of time, but by its means much valuable information as to the occurrence and distribution of minerals (which it is the function of the Department to secure) would probably be otherwise unobtainable or at any rate take many years to acquire. Since the present department was instituted there have been 5,816 free assays made, in addition to a number for which payment has been received.

A good deal of the work of the laboratory is necessarily of a routine character, and much of it is embodied in the various official bulletins and annual reports. During the progress of this work there have been made 177 complete analyses of rocks, 78 mineral analyses, 97 analyses of mineral and allied waters, 118 analyses of coal, 114 of lode stuff and ore mixtures, and 59 soil extracts.

The officers of the Survey laboratory occasionally make in the ordinary course of their duties important researches in connection with substances with which geology is concerned, and some years ago a special Bulletin (No. 6), designed to reduce these investigations to a systematic form, was prepared by Mr. Simpson, and made available to the public.

A good deal has also been carried out in what may be called the domain of technology, which in some measure supplements the work of the Survey proper. Amongst this technological work may be mentioned, the researches into the causes of the corrosion of the pipes of the Goldfields Water Supply main, which were carried out in 1906; the information obtained as a result of the laboratory investigations of the soils from the pipe track, and their effect upon pipe steel and iron are of considerable interest and perhaps of more than mere local importance. In addition a good deal of work is done in what may be called the domain of metallurgical chemistry, although it ought to be made perfectly clear that the commercial application of technical processes is not a function of the Department.

PALAEONTOLOGY.

Geology is more or less dependent upon palaeontological research, for without the specific determination of fossils, reports involving a wide range of stratigraphy could not be written, nor geological maps of large areas be properly completed, though, of course, those acquainted with geological field work, and the running of geological boundary lines are aware that palaeontology only plays an insignificant part in the actual construction of the maps. Palaeontology constitutes the timepiece of geology, serve ing the same purpose as do watches and clocks for the ordinary engagements of life.

Many biologists, it may be noted with regret, look somewhat askance at Palæontology on account, perhaps, of the absence of the softer portions of fossil organisms. The hard parts of organisms are so intimately related to the soft parts that whatever affects the latter is ultimately expressed in the framework. However this may be, palæontological researches do give the true key of the order of succession of organisms by actual observation in the field, and not by speculative groping in the study and the laboratory on recent organisms. By its means we learn much of some of the characteristic features of the geological systems, and thus gradually acquire that knowledge of the geographies of past eras which is really geology.

Fossils being of such importance in determining the relative age, succession and correlation of strata, that the investigation of the Palæontology of a formation becomes an important factor in the early attempts at the development of the mineral resources of regions in which the stratigraphy has been but imperfectly worked out.

A very noteworthy instance of the importance of the study of the fossil fauna occurs in Victoria, where the Ordovician auriferous beds contain Graptolites, arranged in zones according to the presence of certain specific forms. They thus afford a means of providing geological bench marks which will materially assist, in the absence of other lithological methods of determining the boundaries of the barren and auriferous belts in the Ordovician beds.

Most of the fossils in the possession of the Department have been collected by the staff during the progress of the field work. Each fossil received at the office is numbered and registered in such a permanent way that its source and destination can at once be found. All the specimens are forwarded to Mr. R. Etheridge, the highest recognised authority on Australian fossils, who acts gratuitously in the capacity of Palæontologist to the Survey. This gentleman has enriched geological literature with his reports on the collections which have been sent to him from time to time, and which have appeared in our series of palæontological contributions to the geology of the State.

Other contributions are from the pen of Mr. Howchin, of the University of Adelaide, whose detailed descriptions of the Foraminifera of the chalk of Gingin make an important addition to the knowledge of a group of organisms to which but little local attention has as yet been paid.

Valuable work has been done by Mr. Chapman, of the National Museum, Melbourne: his investigation of the fossils of the Collie River Coal Measures has gone a long way towards solving the vexed question of the geological age of the series.

Mr. Newell Arber, the well-known palæobotanist, has described the plant remains from the Jurassic Beds of the Champion Bay district, which has enabled a correlation to be effected with their probable stratigraphical equivalents in Queensland, viz., the plant-bearing beds of Talgai, Darling Downs, and Rosewood, near Rockhampton.

Dr. Geo. J. Hinde's, F.R.S., researches in connection with the fossil sponge spicules from the so-called Deep Lead at Norseman is perhaps one of the most important of our additions to the Palæontology of the State, and to which reference will be made later on.

Finally, my colleague, Mr. Glauert, has drawn up a list of Western Australian fossils, stratigraphically and geologically arranged, to facilitate the work of the Survey, but which will meet a much-felt want at the hands of all workers in, and students of Australian Geology.

The Geological Collection at present contains twenty-one type fossils, *i.e.*, the identical individual specimens from which species have been described.

GEOLOGICAL MUSEUM.

One of the most essential instructional portions of the equipment of the Geological Survey is its museum, in which the various rocks, minerals, and fossils collected by the staff in the ordinary course of its duties, or acquired by purchase, or donation, are exhibited for the convenience of the staff and for the benefit and instruction of the general public. The Survey Collection at present numbers 10,912 specimens.

It was after careful consideration decided by the Government that the small National Geological Collection previously in the hands of the Museum Committee, should be taken over and the collection combined with that belonging to the Survey, and the whole placed under the care and control of the Geological Survey, thus introducing a system of administration, which is only a really scientific classification of functions, with the additional merit of having had successful experience elsewhere to guide it.

The geological collection in the hands of the Museum committee was really too small and insignificant to permit the possibility, having due regard to the other more pressing scientific interests in the Institution, of a specialist being retained for its care, hence by the amalgamation duplication of scientific effort has been reduced to a minimum.

In the general scheme which the Department proposes to ultimately adopt in connection with the arrangement of the geological collections, a plan has been decided upon which will, it is hoped, meet the requirements of four totally distinct classes of visitors to the Geological Gallery, viz., (*a*) the general public, (*b*) the average student, (*c*)the practical man, prospector, engineer, etc., and(*d*) the scientific enquirer. Naturally, as befits such an important mining State as Western Australia which ranks second in the gold-mining countries under the British Flag—the pride of place will be given to collections illustrating the geological structure and mineral wealth of the country, in addition to the application of geology to the various industrial pursuits, without, of course, neglecting the more systematic treatment of the science of geology in general. To this end the mineral rocks and fossils of Western Australia will be properly placed on exhibition, and an endeavour made to display specimens which are especially characteristic of Australasia and elsewhere. The fossils which have been almost entirely collected by the staff and our predecessors in the ordinary course of their duties, from the different formations in the State, will be arranged and displayed primarily in stratigraphical and secondly in zoological sequence in conjunction with the geological maps of the districts in which they were obtained. The rock specimens also will be systematically arranged so as to illustrate the various geological and mining maps ; whilst the extremely valuable collection of minerals and metallic ores will be primarily arranged on a metallic basis, but in such away as to afford a brief *aperçu* of the nature, type, mode of occurrence and geographical distribution of the mineral wealth of Western Australia. In the case of the ores and other minerals all the specimens will, as far as possible, be of a uniform size (and arranged with illustrative plans, diagrams and photographs), such being of greater scientific, commercial, and educational value than large trophies, or bulk samples from individual mines or districts.

Care is being taken to preserve and exhibit only such specimens as are of permanent and real value, and which have a lesson to teach. Carried out on these lines, the Geological Gallery will then be as it ought to be, a collection illustrating in the very widest sense the geological structure, mineral wealth, and past life of Western Australia in its relation to geological science in general.

PUBLICATIONS OF THE SURVEY.

The results obtained by the Geological Survey are made available to the general public in a useful, practical and creditable style in three distinct forms, viz., Annual Reports, Bulletins, and Maps.

The Annual Reports, which are presented every year to Parliament, contain a brief statement of the work of the department for the period by which each is covered, and in addition a good deal of miscellaneous information which it is deemed desirable should be issued in advance of the more detailed reports. Up to the present time fourteen annual Parliamentary documents have been presented. These, in addition to the usual administrative details, will be found to contain 58 reports on auriferous deposits in goldfields: 10 on copper and lead deposits, 7 on the tinfields, 3 on the iron ores of the State, 10 on coal and oil, 3 on phosphates, 12 on other miscellaneous mineral occurrences, 8 reports prepared under the provisions of the Mining Acts, 10 on general geological subjects, 1 on petrography, 1 on palæontology, 2 on mining technology, and 23 on subterranean water supply.

It was very soon found that a good deal of the value attaching to special reports upon the economic aspects of geology was discounted by delay in publication, which must necessarily happen when detailed descriptions are included in the report presented annually to Parliament, and it was ultimately determined in 1899 that when reports and maps upon any special subject or district were prepared, they should be printed in a convenient form, styled Bulletins, and made available for distribution to the public as soon as they could possibly be issued from the Government Printing Office.

These separate reports or Bulletins, which number forty, deal with a great variety of subjects, as may be noticed by an inspection of the published catalogue and table of contents. Of the Bulletins already published, one is a Bibliography of the Geology of the State, three contain valuable palæontological contributions to Western Australian Geology, three deal with Artesian Water Supplies, three on such general questions as the Mineral Wealth of the State, the Occurrence and Distribution of the Base Metals, Minerals of Economic Value (really a valuable hand-book for prospectors and others on Commercial Mineralogy), and a statistical account of the Mineral Production of the State; two refer solely to general geology, whilst twenty-eight give more or less detailed accounts of the geological structure, ore occurrences, and future mining prospects of pretty nearly every field in Western Australia.

Of the Geological, Mining and Topographical maps, there have been issued up to date: geological maps of goldfields 61, copper and lead mining districts 10, tinfields 5, coalfield maps 5, general geological maps 28, mining maps and plans 92, mineral distribution maps 4, of topographical maps 4, and horizontal and vertical sections 10.

An inspection of the various geological maps shows that the titles attached to each explain the degree of accuracy or precision of the field work, and that the geological groups are shown in colours. The colours used, it may be explained, are not based upon any mere arbitrary scheme. The question of the colouration to be adopted in geological maps is one of which very few geologists have had any wide experience. In the Western Australian maps the colours employed for the expression of the geological formations are as nearly as possible those adopted by the International Geological Congress, which meets every three years. The guiding principle in this scheme is, briefly, that the older the formation the deeper is the tint. It will be noticed that the colours on the Survey Maps are employed in two distinct ways: 1st, solid, *i.e.*, completely covering the surface and in pale tints, and 2nd, in patterns. The first use is designed to have a chronological function, whilst the second indicates the several subdivisions, or varieties of rock masses, etc. To guard against the risk of the so-called "fast colours" fading, each is also distinguished by a special symbol. This identity of colours and patterns is essential when the maps are to form part of a series, and the various formations are to be compared one with another. It is, of course, difficult to devise a scheme of colouration that will meet universal requirements. The adjustment of the details of the International scheme of Geological Map Colouration to the requirements of the large scale and detailed maps of mining fields, etc., has proved a well-nigh insurmountable difficulty, though on the whole it is sufficiently close to be intelligible to those familiar with the system in question.

The writing of reports, and the other duties incidental thereto, naturally take time, and few people, unless those who have had to do it, adequately realise the labour involved in the preparation of such if they are to have scientific and official accuracy. Hastily written reports are of little real service, of no permanent value, and in many cases tend to materially defeat their own ends.

For reasons which can be readily understood, geological inquiry in Western Australia has up to the present consisted chiefly of a series of unconnected observations to the co-ordination of which we must look to the future.

Little or no progress has as yet been made in the direction of the correlation of the various geological horizons with those of Australasia and other neighbouring countries, though our observations, having been carried out in all portions of the State, do permit of certain broad generalisations. A great deal of the work of the Survey is necessarily scattered through the various bulletins, annual reports and official documents, hence it has been felt that the time has arrived when an attempt ought to be made to gather and put into a concise form a systematic account of the geology and mineral and allied resources of the State, illustrated by a large scale geological map of Western Australia, which shall show the present condition of our knowledge. Many intelligent people who are not geologists desire to know something of the geological structure and geological history of the State, and to them as well as to others such a work will it is hoped, meet a much-felt want.

The task which this literary work involves is a heavy one, and will naturally take a good deal of time to accomplish, seeing that much office work must be done on the Survey Collections, and much literature, etc., abstracted before all the information at our command regarding the geology and mineral resources of the State can be systematically presented ; still, it is hoped that the map, at any rate, will be ready for the lithographer by the close of this year.

SCIENTIFIC RESULTS.

The work which has already been completed has achieved certain valuable results. Whatever new facts may have been contributed to science as a result of the Survey's operations, have been solely arrived at in the prosecution of economic inquiries carried out in what I conceive to be a scientific manner. It is, of course, almost impossible to estimate the indirect usefulness of the work of the Survey, which is to be looked for both in the State and out of it : in Western Australia in the economic development of the State, and out of it in the influence it has on the advancement of geological science. The effect of its work upon the various industries and upon the wealth and prosperity of Western Australia is naturally that to which the Government attaches the greater importance.

Time, however, will hardly admit (though there is the inclination) of any detailed reference being made to many of those practical and theoretical questions arising out of the data which have been amassed ; amongst the more important results, however, may be mentioned :—

(*a*) The subdivision and structural features of the fundamental complex of crystalline schists and other metamorphic rocks, which form the staple formation of our gold and mineral fields, have been more or less tentatively established. These form an important group of rocks, the members of which have certain features in common, occupying definite areas while various lines of enquiry point to these being of considerable geological antiquity, probably Pre-Cambrian ; they also likely contain the materials for about one half of the geological history of the earth.

(*b*) The investigations carried out on what may be called the Auriferous Series, as developed on most of our goldfields, has shown that an intimate relationship subsists between the intrusive granite masses and the auriferous quartz veins and other allied mineral deposits.

(*c*) Having due regard to the extent of these old rocks and the fact that Western Australia has been remarkably stable and quiescent since early Palæozoic times, the State may be said to possess almost limitless mining possibilities.

(*d*) The stratigraphy of that important formation, the Nullagine Series, has now been clearly defined. This formation consists of a great thickness of quartzites, sandstones, conglomerates and dolomites, together with a series of lavas, ashes and agglomerates of as yet unascertained thickness. The dolomitic limestones of the Nullagine Series afford evidence that a large portion of Western Australia north of Lat. 26° has been subject to marine conditions, and point to a more or less prolonged submergence during a very early period in the Earth's history. The Nullagine Series is of some economic importance by reason of the fact that its basal members have proved to be auriferous in two localities. In many important respects these gold deposits bear a striking resemblance to those celebrated auriferous conglomerates of the Rand, in South Africa, better known, perhaps, as the Banket Deposits. The series is also of importance, owing to the fact that the soil derived from the volcanic beds produces that excellent pastoral country which occurs in the recesses of the Hamersley Range.

(*e*) The question of the geological age of the Collie River Coal Measures, which was formerly more or less obscure, has now been very clearly settled by a careful investigation of the organic remains associated with the strata; a result which adds considerably to our knowledge of the important scientific question of the distribution of the Glossopteris Flora.

(*f*) One of the most important advances in Western Australian geology is the recognition of a glacial conglomerate in the Marine Permo-Carboniferous Rocks, near the Tropic of Capricorn. This conglomerate, which forms a very valuable stratigraphical horizon, has been traced across country for nearly 200 miles, and is exposed in the valleys of the Minilya, Lyndon, Lyons, Arthur, Wyndham, Wooramel, and Irwin Rivers. The scientific interest attaching to this deposit lies in the fact that it marks the prevalence of intense cold, and a distinct glacial epoch, which there are sound geological reasons for believing to be contemporaneous with the glaciation that affected India, South Africa, the Argentine, the Falkland Islands, and other portions of Australasia in Permo-Carboniferous times.

(*g*) The recent recognition of another Mesozoic horizon, viz., the Cretaceous chalk at Gingin, makes an important advance in our knowledge of the younger geological formations, and it is hoped that steps may shortly be taken to accurately define in the field its relationship to the Jurassic Beds to the north, and the artesian water-bearing strata which underlie the metropolitan area.

(*h*) Perhaps the most important recent additions to our knowledge is the recognition of a deposit made up solely of fossil sponge spicules in the so-called Deep Lead at Princess Royal township, near Norseman, at an altitude of about 700 feet above sea-level. Dr. G. J. Hinde, F.R.S., into whose hands the Department entrusted this material for examination, reports that the deposit is not merely local, but must have been formed in the open ocean at some distance from the coast line and probably at a considerable depth. This discovery is of considerable importance and will have to be thoroughly examined some day as it involves a whole series of important conclusions regarding the physiographical changes in the district, which depend upon the geological age of the deposit. The solution of the many economic questions involved in the stratigraphical research which such an investigation entails is of no less importance to the community than the purely scientific results which of necessity follow.

(*i*) Important additions have been made to the sum total of our knowledge in regard to the geological conditions obtaining in the various portions of the State in which artesian water occurs. Actual boring operations have demonstrated the accuracy of the geological deductions, and land that hitherto could not be made effective use of has been taken up and stocked, thus increasing the woolclip and the stock-carrying capacity of the State.

My self-imposed task is now ended and in the fulfilment of the task I have endeavoured to show concisely how the Department came into being, the purpose for which it exists, how it carries out its work, something of what it has been able to accomplish, and how in the highest sense it has endeavoured to justify the conception that "Geological Science is not only the interpreter of Nature, but the Servant of Humanity."

Pilbarite, a New Mineral from the Pilbara Goldfield.

BY EDWARD S. SIMPSON, B.E., F.C.S.

(*Read Aug. 16, 1910.*)

The mineral described in this paper has recently been found in small quantities above the water level in the main tantalite lode on Mineral Lease 86, at Wodgina, Pilbara Goldfield. The geology of this district and the nature of the tantalite lode have been dsecribed by our President in Bulletins 23 and 40 of the Geological Survey of Western Australia. The tantalite leases are pegged out on hilly country composed of greenstone schists, which are penetrated by numerous veins of pegmatite, these being at times sufficiently rich in tin and tantalum to constitute "lodes." The main tantalite lode is a strong pegmatite vein whose outcrop has been traced in a north and south direction over a length of more than half a mile. Practically the whole tantalite yield of Wodgina has been obtained from this lode or from surface fragments weathered out of it. According to Mr. Maitland's description, the chief constituents of this vein are albite and quartz. Some portions consist almost wholly of albite, others of quartz, whilst occasionally fine scaly lepidolite is a prominent mineral. Orthoclase, manganotantalite and cassiterite have been recorded from it, and to this list must now be added Pilbarite.

A few months ago a few fragments of a bright yellow ochreous mineral from this lode were sent to the author for determination. These were found to be strongly radio-active and to contain a considerable percentage of uranium and thorium. Such minerals being of considerable interest and value at the present time, a further supply was asked for, and in response to this request a sample of about two pounds in weight was received. A very full examination of this mineral has therefore been possible of accomplishment.

The mineral is in nodules from the size of a pea up to that of a walnut. The largest piece weighs 30 grammes, the average size of fragment being about 5 grammes. The fragments are subangular in outline and in one or two instances portions of the surface suggest crystal faces. It is evident that this mineral is a hydrous pseudomorph after a probably anhydrous parent mineral. Examination under the microscope showed that it is amorphous and of a colloidal gelatinous or gummy texture. Such slight indications of cleavage and external crystalline form as are observed evidently owe their origin to the parent mineral and are not inherent characteristics of Pilbarite itself.

The interior of the nodules is of an almost uniform bright canary yellow colour, the exterior is disguised somewhat by a brownish or reddish coating, covering a thin slightly bleached zone of mineral The chief characteristics have been determined on material from the surface of which about two or three millimetres had been removed. The interior of the nodules thus prepared was found in thin slice under the microscope to be homogeneous except for some streakiness of colour ,due probably to slightly different degrees of hydration or to slight staining in places with ferric hydrate. A few minute specks of tantalite were thus seen embedded in the mineral and a little colourless mineral which appeared to be an altered felspar. The mineral is opaque in layers thicker than one-fifth of a millimetre. Colour, canary yellow. Brittle, earthy, amorphous. Hardness, 2.5 to 3. Specific gravity, 4.4 to 4.7. Strongly radioactive. Composition, hydrated silicate of lead, uranium, and thorium. The analysis of a well scraped fragment weighing 6 grammes yielded the results given in column I below.

	I. Pilbarite. Wodgina	II. Thorogummite. Texas.	III. Mackintoshite. Texas.	IV Uranophane. (Uranium ochre). Saxony	V. Urano-thorite.* New York State.
Uranium trioxide, UO_3	27.09	22.43	22.40†	62.84	9.96
Thoria, ThO_2	31.34	41.44	45.30	...	52.07
Ceria, Ce_2O_3	.19	6.69		...	...
Yttria, Y_2O_3	.49		1.86	...	...
Alumina, Al_2O_3	.15	.96	...	trace	.33
Ferric oxide, Fe_2O_3 ..	.20	.85	§ 1.15	2.88	4.01
Lead oxide, PbO	17.26	2.16	3.74	...	.40
Lime, CaO	.57	.41	.59	5.49	2.34
Magnesia, MgO	.21	...	.10	...	.04
Manganese oxide, MnO	trace	...	...	...	...
Potash, K_2O.........	.09	...	.42	...	.11
Soda, Na_2O..........	.04	...	.68	...	
Silica, SiO_2	12.72	13.08	13.90	14.48	19.38
Phosphoric oxide, P_2O_5	1.08	1.19	.67	...	...
Tantalic oxide, Ta_2O_5	.47	...	.88	...	...
Water above 100°, H_2O	4.16	7.88	4.31	13.79	11.30
Water at 100°, H_2O ..	3.50	1.23	.50		
Helium, He	trace	...	...	...	...
	99.56	98.32	96.50	99.48	99.95
Sp. gr.	4.68	4.50	5.44	3.86	4.13

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* Uranium—bearing variety of thorite

† UO_2 § FeO

The composition of related minerals is shown in columns II to V.

According to Rutherford and Boltwood's value for the ratio of radium to uranium in such minerals, Pilbarite would contain about 7.5 centigrams of radium per ton, according to Mme. Gleditsch's‡ values, probably somewhat less, being a weathered compound.

In calculating a formula for Pilbarite, the whole of the tantalic oxide and the requisite amount of manganese and iron oxides to form tantalite are rejected, there being abundant evidence in support of this. The traces of alumina and alkalis are also neglected as being certainly present as inclusions of mica and felspar. The phosphoric oxide is probably present as monazite or xenotime. The essential constituents are evidently—

UO_3	.094	molecules
ThO_2	.118	,,
(Pb. Ca. Mg)O ..	.092	,,
SiO_2	.202*	,,
H_2O+	.231	,,
H_2O-	.195	,,

The formula for Pilbarite is therefore—

$$UO_3 . ThO_2 . PbO. 2SiO_2 . 2H_2O. +2H_2O.$$

The only two minerals with a formula approaching this are—

Thorogummite, $UO_3 . 3ThO_2 . 3SiO_2 . 6H_2O$; and
Mackintoshite, $UO_2 . 3ThO_2 . 3SiO_2 . 3H_2O$.

Both of these minerals crystallise in the tetragonal system. It is evident that in the presence of lead oxide as an important constituent and also in the relative proportions of uranium oxide, thoria, silica and water, Pilbarite differs essentially from these minerals. In crystalline form it also differs essentially and one is therefore justified in considering it a new species.

Pilbarite dissolves readily in strong or slightly diluted hydrochloric acid, leaving a flocculent residue of silica. It is completely decomposed by nitric and sulphuric acid, either concentrated or moderately dilute, but with these acids in addition to silica a bulky mass of difficultly soluble thorium and lead salts separates out. During decomposition with hydrochloric acid a fair number of gas bubbles were seen to be given off, which were at first taken to be carbonic acid, but in view of the possibility of helium being present as the result of degradation of uranium special efforts were made to collect the gas free from air or other gaseous impurities and to examine it. The apparatus used was simply made but quite effective for the measurement of the helium to one-fiftieth of a cubic centimetre. It consisted of a so-called micro-chemical gas bottle of 125 c.c. capacity. By means of a short length of pressure tubing, a T piece of glass tubing with two stopcocks was connected to the mouth of the bottle. The unstoppered leg of the T-piece to the side was closed by a short length of rubber tubing with a glass stopper. The upper part of the T tube was graduated to tenths of a c.c. The side tube of the bottle was connected to a two bulb reduction tube to act as a balance. The mineral being placed in the bottle with a little water, it was heated to boiling to expel any air within the pores of it. The apparatus was then fitted together and filled completely with cold recently-boiled acid, the top stopcock closed and the bottle placed on the water bath for several hours. The helium was determined in both uncrushed and finely crushed mineral. Since Moss * has shown that helium escapes on grinding a radio-active mineral and since the generally accepted theory is that helium is only mechanically imprisoned in the mineral, † it was to be expected that more helium would be obtained from the uncrushed than from the crushed mineral. The actual results obtained were—

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‡ Chemical News, Vol. C., p. 173.

* Neglecting SiO_2 present as felspar.

Mineral taken gms.	2.5	2.5	2.5	2.5
Condition	Crushed	Crushed	Uncrushed scraped	Uncrushed unscraped
Acid	5E HCl	5E H_2 SO_4	5E HCl	5E HCl
Helium, c.c. at N.T.P.	0.55	0.65	0.96	0.97
Helium per gm. of mineral	0.22	0.26	0.38	0.39

Sulphuric acid was found to be the best for the liberation of helium from the powdered mineral, hydrochloric being so rapid in action that the apparatus could not be filled and stoppered without loss of gas. In the case of the uncrushed mineral, which was in masses of about 0.5 gm. each, sulphuric acid was found to be useless, as it failed even after two days to penetrate to the centre of the mineral, which became protected by a coating of insoluble sulphate of lead and thorium. Hydrochloric acid of 5E strength on the contrary was found to be conveniently slow in action in the cold and very energetic on heating, lead uranium and thorium rapidly dissolving and leaving a flocculent mass of silica. The greater part of the helium was obtained in this way in half an hour, the whole of it at the end of about eight hours. By occasionally compressing the short rubber tube on the side limb of the T piece the whole of the helium was made to collect in the upper graduated part of the apparatus. After replacing the acid in the T piece by freshly boiled water the gas was measured at atmospheric pressure and its volume reduced to normal temperature and pressure.

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* Trans. Roy. Soc. of Dublin, 1904.

† Rutherford, Radioactivity, 2nd Edition, p. 485.

As to the nature of the gas evolved, it was found to suffer no diminution in volume when agitated with caustic potash solution or with alkaline pyrogallate. It was not therefore either carbon dioxide or oxygen. With the kind assistance of Mr. J. B. Allen an attempt was made to prepare a spectrum tube of the gas, but in the absence of suitable tubes all our efforts resulted in failure. Whilst positive evidence of identity is lacking, there can be no doubt that the gas was wholly or almost wholly helium, a gas given off in greater or less quantity from all radioactive minerals when suitable means are taken to release it.

The greatest interest attaches to the accurate determination of the helium in radioactive minerals since recent researches, particularly those of Rutherford and Strutt, have indicated that helium may by its slow accumulation be acting as a chronometer of geological time. The assumptions on which the calculations are based are :—

(1) Uranium, radium, thorium and other associated radioactive matters are producing helium during thier atomic disintegration at a very slow rate which has already been measured with some degree of accuracy ;

(2) This production of helium would begin in a radioactive mineral immediately it consolidated from aqueous solution or igneous fusion ;

(3) Only negligible quantities of helium would be able to escape from the mineral until disturbed by man, by far the greater part being occluded in the mineral in masses approximating atomic dimensions, and under conditions of great condensation. Leakage of helium commences immediately the minerals are liberated from the enclosing rock.*

Working on the mineral zircon from lava of known ages, Strutt† showed that the ratio of helium in cubic centimetres to uranium oxide in grammes was a function of the age of the mineral. In calculating this ratio thoria is reckoned as equivalent in helium production to one-fifth its weight of uranium oxide ($U_3 O_3$). This ratio was found to be less than unity for rocks of Tertiary age, between 10 and 30 for rocks of Palaeozoic age, and over 50 in the case of a single rock of Archaean age. The " Helium ratio " for this Pilbarite is 2.9, which would indicate that this mineral was evolved from its parent in Post-Palaeozoic times, if all previously accumulated helium be assumed to have been liberated during the hydration and possible oxidation which then took place.

Strutt, Proc. Roy. Soc. Jan. 1909.

† „ „ „ „ Dec. 1909.

Working on the principles outlined above, an attempt might even be made to estimate the age of the mineral in years. The figures are :—

U_3O_8 in mineral	26.58 per cent.
U_3O_8 equal to ThO_2 in mineral	6.26 per cent.
Total U_3O_8	32.84 per cent.
U in one gram of mineral	0.2785 gm.
Ra per 1 gm. of U	3.4×10^{-7} gm.
Ra per 1 gm. of mineral	9.47×10^{-8} gm.
He evolved per year per 1 gm. Ra	3.16×10^{-1} c.c.
He evolved per year per 1 gm. mineral	29.9×10^{-9} c.c.
He found in 1 gm. mineral	0.385 c.c.

Age of mineral in years, $0.385 \div (29.9 \times 10^{-9}$ c.c.) = 13 millions.

At least two counterbalancing effects vitiate the above result to an unknown amount. These are the leakage of helium from the mineral before its estimation and secondly the unknown amount fo helium generated by the parent mineral and retained by Pilbarite at the outset of its existence as such.

It is evident from what has been said that Pilbarite is strongly radioactive. To test this photographically a special rapid plate was covered by a sheet of black glazed paper which was again covered by a mask of lead foil pierced by a pattern. Over the lead foil was a sheet of thin tissue paper and on that a heap of powdered Pilbarite was placed. After 48 hours the plate was developed and a strong radiograph obtained, of the perforations in the lead. An appreciable amount of radiation had also passed through the lead foil, which was only 0.13 mm. in thickness, the outlines of the heap of powdered mineral being clearly discernible.

A freshly scraped fragment of Pilbarite placed in a Glews scintilloscope yields a rapid succession of flashes due to the emission of alpha rays, i.e., to the impact of electrically charged atoms of helium on the screen of zinc sulphide.

Heated in a closed or open tube, Pilbarite gives off much water and darkens somewhat in color. Before the blowpipe on charcoal it is infusible and turns black. If some of the powdered mineral be heated with sodium carbonate on charcoal, a black slag is formed in which small globules of metallic lead can be seen. A fragment heated in a microcosmic salt bead gives the reactions of uranium, an unaffected residue of silica and thorium remaining.

A search was made for evidences of radioactivity in the hornblende schists enclosing the lode in which Pilbarite occurs. When a small crystal of even a moderately radioactive mineral (such as radium-bearing varieties of zircon, apatite or allanite) is enclosed in hornblende, biotite or other similar mineral, the effect of the active rays on the enclosing mineral can be clearly perceived under the microscope. For a distance of about one-twentyfifth of a millimetre in every direction from the surface of the active mineral the enclosing hornblende is discoloured, and this discoloured portion of the matrix is usually more strongly pleochroic than the unaffected portion. Such pleochroic halos, as they are called, are spheroidal or ellipsoidal, according to the shape of the crystal of zircon, etc., which gives rise to them. It is interesting to note that they were found to be abundant in the hornblende of the Wodgina schists. The phenomenon is of course known in many other parts of the globe, particularly, so far as this State is concerned, in rocks from Kalgoorlie, Ravensthorpe, and the Darling Ranges.

Second Abstract of the Reports of the German Expedition of 1905 to South-Western Australia.

BY PROF. W. MICHAELSEN.
Communicated by Bernard H. Woodward, C.M.Z.S., F.G.S.,
Director, Western Australian Museum.
28th July, 1909.

Being a Resumé of "Die Fauna Sudwest-Australiens," Vol. I,
Parts 1 *to* 13, *Jena, G. Fischer,* 1907-8,
the scientific results of the "Hamburger Sudwest-australische Forschungsreise, 1905,"
and edited by Drs. W. Michaelsen and R. Hartmeyer.

(Read December 13th, 1910.)

The first volume of this collaborative work was completed in 1908, the first seven parts having been issued in 1907. It consists of thirteen parts, the first part gives a general account of the expedition, whilst each of the others treats of one particular systematic group of animals. These parts are not arranged in any definite order of classification, but in that of the completion of their manuscripts by the various authorities engaged upon the work

PART I.

This is a general account of the expedition and is written by Prof. W. Michaelsen, of Hamburg, and Dr. R. Hartmeyer, of Berlin. It consists of pp. I to VIII and 1 to 116, with 49 figures in the text and one map. The Introduction and the chapters "Arrival and the arrangements made in Fremantle," "Fremantle to Perth, "Rottnest," "Overland Excursions," "Physiography of the Country," "The Flora," "The Fauna," "The Aborigines," and "The Timber Industry and Farming" are written by Dr. Michaelsen. The second portion, consisting of the chapters on "Sheep Farming," "The Mines," and a "Study of the Marine Fauna," are by Dr. Hartmeyer. Appended to this are a list of the localities and a map showing where the collections were obtained.

PART II.—OLIGOCHAETA.

By Prof. W. Michaelsen.

Pp. 117 to 232, with Plates I and II, a map, and 34 diagrammatic figures.

Introduction.—Hitherto not a single species of Oligochaeta had been recorded from S.W. Australia, the known members of this group being confined almost exclusively to the Eastern States, the only species from outside that area previously described being a few from South Australia, one from Central Australia, and one from the North-West.

Then follows a general description of the Oligochaeta and a list of the discoveries in the South-West, which includes 52 species belonging to 18 genera, viz. :—

Family NAIDIDAE.

Genus *Pristina.*—1 known species ; fluviatile ; widely distributed.

Family TUBIFICIDAE.

,, *Clitellio.*—1 new species ; marine ; endemic.

Family ENCHYTRAEIDAE.

,, *Enchytraeus.*—1 known species ; terrestrial and littoral ; introduced.
,, *Michaelsena.*—2 new species ; marine and fluviatile ; endemic.
,, *Fridericia.*—1 known species ; terrestrial ; introduced.

Family HAPLOTAXIDAE.

,, *Pelodrilus.*—2 new species ; fluviatile ; endemic.

Family MEGASCOLECIDAE.

Sub-Family Acanthodrilinae.

,, *Eodrilus.*—1 new species ; terrestrial ; endemic.
,, *Microscolex.*—2 known species ; terrestrial and littoral ; introduced.

Sub-Family Megascolecinae.

,, *Plutellus.*—11 new species ; terrestrial ; endemic.
,, *Pontodrilus.*—1 new, 1 known species ; littoral ; endemic ; 1 sp. widely distributed.
,, *Megascolides.*—1 new species ; terrestrial ; endemic.
,, *Woodwardia.*—4 ,, ,, ,, ,,
,, *Notoscolex.*—6 ,, ,, ,, ,,
,, *Megascolex.*—11 ,, ,, ,, ,,
,, *Pheretima.*—1 known species ; terrestrial ; introduced.

Family LUMBRICIDAE.

,, *Eiseniella.*—1 known species ; terrestrial and fluviatile ; introduced.
,, *Eisenia.*—1 known species ; terrestrial ; introduced.
,, *Helodrilus.*—3 ,, ,, ,, ,,

The fluviatile Oligochaeta are very rare. They belong to orms of which the genera, and in many cases the species also, ave an almost world-wide distribution. The marine and littoral pecies, too, although partly new, do not show any well-marked istinctions from known species. As before stated, the principal eographical interest is attached to the terrestrial forms, but rom these must first be separated those species which have been ntroduced by man. Of these latter, two, viz., *Helodrilus caliginosus* (Sav.) and *Microscolex dubius* (Fletch.) are the commonest Earthworms in South-West Australia, having been found in almost every locality visited.

The endemic earthworms (34 new species) all belong to the family Megascolecidae and are remarkable for their small size, only a few species, viz., *Megascolex imparicystis*, *M. monostichus*, *M. harveyensis*, *Plutellus strelitzi* and *P. woodwardi* being of even moderate dimensions.

The Geographical Relations and Geographical History of the Country.—These need not be gone into here, as the conclusions arrived at are almost identical with those mentioned in the first abstract*; it must, however, be stated that after more exact examination the generic districts were found to be even more restricted than at first supposed. For example, the new genus *Woodwardia*, which has been separated from the larger genus *Notoscolex*, is confined to a very small district, including Lion Mill, Subiaco, and Jarrahdale.

Systematic List of Species from South-Western Australia:—

Family NAIDIDAE.

Pristina longiseta (Ehrbg.).—Brunswick, in a stream; a widely-distributed species.

Family TUBIFICIDAE.

Clitellio abjornssoni, n. sp.—Rottnest, Albany, on the beach and in the sea as far as a depth of 9 m. (4 to 5 fathoms). The original monograph includes a discussion of the genera *Clitellio* and *Rhizodrilus*.

Family ENCHYTRAEIDAE.

Enchytraeus albidus (Henle.).—Albany, Geraldton (?), in the sea at a depth of 5½-9 m. (3 to 5 fathoms), on the beach (?). A widely distributed species. Perhaps imported by man.

Genus *Michaelsena*. Description of the arrangement of the setae in this genus and discussion of its affinities (allied to *Fridericia*?).

Michaelsena principissae, n. sp.—Albany, on the beach. Relationship of this species to *M. paucispina* (Eisen), *M. unisetosa* (Ferronn), and *M. macrochaeta* (Pierant).

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* This Journal, Vol. II., Part 5.

Michaelsena normani, n. sp.—Brunswick, in a stream. Relationship of this species to *M. subtilis* (Ude). *M. normani*, probably a marine species immigrated from the sea into the river and its tributaries.

Fridericia galba (Hoffm.).—Albany, in swampy ground; widely distributed species, no doubt imported by man.

Family HAPLOTAXIDAE.

Genus *Pelodrilus*.—Discussion of the relationship of this genus to *Haplotaxis*.

Pelodrilus darlingensis, n. sp.—Collie, in swampy ground. Relationship of this species to *P. africanus*.

,, *hologynus*, n. sp.—Yarloop, Harvey, in wet earth in the banks of a stream. Intermediate between the genera *Haplotaxis* and *Pelodrilus* as before determined. Relationship to the Siberian species, *P. ignatovi* (Michlsn.).

Family MEGASCOLECIDAE.

Sub-Family ACANTHODRILINAE.

Genus *Eodrilus*, nov. gen.—Separated from the older and larger genus *Microscolex* (*Notiodrilus*) type species: *Eodrilus cornigravei*, n. sp. Discussion of the Sub-Family Acanthodrilinae and new arrangement and definition of its genera.

Eodrilus conigravei, n. sp.—Cannington, in swampy ground.

Microscolex dubius (Fletch)..—Widely distributed species, imported by man; one of the two commonest species in S.W. Australia; found in nearly all the terrestrial localities visited, as well as in a littoral one near Dongarra.

,, *phosphoreus* (Ant. Dug.).—Cannington, Donnybrook; widely distributed species, introduced by man.

Sub-Family MEGASCOLECINAE.

Discussion of the morphological and systematic relations in this sub-family, and new definition and arrangement of its genera.

Plutellus termitophilus, n. sp.—Lunenberg, in the comparatively hard earth of Termites' (white ants') nests.

,, *wellingtonianus*, n. sp.—Collie, in wet earth.

,, *strelitzi*, n. sp.—Lion Mill, in comparatively hard and dry earth beneath stones.

,, *woodwardi*, n. sp.—Collie, in swampy ground under logs.

,, *levis*, n. sp.—Cannington, in swampy ground under stones.

,, *murrayensis*, n. sp.—Jarrahdale.

,, *mendilai*, n. sp.—Eradu, under stones on the banks of the nearly dried up Greenough River.

,, *blackwoodianus*, n. sp.—Bridgetown, under stones in the bush.

Plutellus schumanni, n. sp. –Albany, between grass-roots at the side of a trench.
,, *carneus*, n. sp.—Albany, in the same locality.
,, *asymmetricus*, n. sp.—Albany.
,, sp. (?)—Dongarra, in a garden.
Pontodrilus albanyensis, n. sp. -Albany, on the beach. Relationship to *P. matsushimensis* (Irzuka).
,, *ephippiger* (Rosa). Denham, on the beach; widely distributed littoral species. Rejection of the variety *laysaniana* (Michlsn.).
Megascolides nokanenaensis, n. sp. –Northampton, under a stone in a swampy meadow.
Genus *Woodwardia*, nov. gen.—Separated from the old and larger genus *Notoscolex* (s.l.) Type species, *Woodwardia callichaeta*, n. sp.
Woodwardia callichaeta, n. sp. Jarrahdale, under stones.
,, *affinis*, n. sp.—Jarrahdale, under stones.
,, *lipferti*, n. sp. –Subiaco, in the bush, under a log.
,, *molaeleonis*, n. sp.—Lion Mill, under logs and rotting bark.
Notoscolex maecenatis, n. sp.—York, in rotting saw-dust.
,, *hortensis*, n. sp. Dongarra, Lion Mill, Jarrahdale, Gooseberry Hill, in gardens and beneath stones, logs and decaying bark; this species is to some extent a migratory one.
,, *prestonianus*, n. sp.—Donnybrook, beneath stones on the bank of the Preston River.
,, *modestus*, n. sp.—Yarloop, York.
,, *rubescens*, n. sp. -Pickering Brook, under stones in comparatively hard and dry ground in the bush.
,, (*Trinephrus*) *suctorius*, n. sp. Bridgetown, in rotting tree trunks; doubt felt about the validity of the gen. *Trinephrus* (Bedd.).
Megascolex imparicystis, n. sp.—Western Australia, exact locality unknown.
,, *harveyensis*, n. sp.—Harvey, in wet ground under logs.
,, *whistleri*, n. sp.—Boyanup, under logs.
,, *purpurascens*, n. sp. Donnybrook, under stones in comparatively dry and hard ground in the bush.
,, *bistichus*, n. sp.—Donnybrook, in the same locality as above.
,, *monostichus*, n. sp.—Torbay, beneath the bark of rotting trunks in the forest.
,, *torbayensis*, n. sp. Torbay, beneath the bark of rotting trunks.
,, *colliensis*, n. sp. -Collie, Lunenberg, between grass roots and stones. The single specimen from Lunenberg differs somewhat from the Collie specimens.

Megascolex albanyensis, n. sp.—Albany, in the rotting centre of the trunk of a Blackboy (Grass-tree), *Xanthorrhoea*

,, *galei*, n. sp.—Collie, under logs in comparatively hard and dry ground.

,, *collinus*, n. sp.—Broome Hill

Pheretima heterochaeta (Michlsn.).—Boyanup, beneath a plank in an orchard. A widely distributed species, introduced by man. Then follows a discussion of the systematic relationship of this species to its allies.

Family LUMBRICIDAE.

Eiseniella tetraedra (Sav.), forma typica.—Albany. A widely distributed species introduced by man.

Eisenia foetida (Sav.).—Albany, nearly cosmopolitan, introduced by man.

Helodrilus (*Allolobophora*) *caliginosus* (Sav.). A nearly cosmopolitan species introduced by man; one of the two most common in S.W. Australia, found in nearly all the terrestrial localities visited.

,, (*Bimastus*) *parvus* (Eisen). Mundaring Weir. A widely distributed species introduced by man.

,, (*Bimastus*) *constrictus* (Rosa).—Cranbrook, Albany. A widely distributed species introduced by man.

PART III. COPEOGNATHA.

By Dr. Gunther Enderlein, of Stettin.

Pp. 233-240, with 6 figures in the text.

Of special geographical interest are *Echmepteryx hartmeyeri*, n. sp., and *Hyperetes australicus*, n. sp., as Lepidopsocids and Atropids were not previously known from Australia. Then follows a list of the Australian Copeognatha, including those of this collection, the first recorded from S.W. Australia. In the special part are enumerated and described the following species and genera of the Copoegnatha :—

Lasiopsocus, nov. gen.—Type species: *Lasiopsocus michaelseni*, n. sp.

Lasiopsocus michaelseni, n. sp.—Yalgoo, Borrabin.

Psocus irroratus, n. sp.—Yalgoo.

Cladioneura pulchripennis (Enderl.).—Dirk Hartog; previously recorded from New South Wales.

Echmepteryx hartmeyeri, n. sp.—Karrakatta.

Hyperetes australicus, n. sp.—North Fremantle.

PART IV.—OPHIUROIDEA.

By Prof. R. Koehler, of Lyons.

Pp. 241-254, with 10 figures in the text (in French).

The collection contains 28 species, three of which are new, while the 25 species already known are of special interest. The first glance at the list shows that almost all the Ophiurids belong to the Indo-Pacific fauna. Twenty of them are characteristic of this fauna and had already, with few exceptions, been described by Prof. Koehler in his Monograph on the littoral Ophiurids of the "Siboga" Expedition. Among the remaining 5 species, three do not strictly belong to the Indo-Pacific region, but may be included in it; they are *Ophiomyxa australis*, chiefly distributed over the southern coasts of Australia, but also found by the "Challenger" at Amboina, and even at the Phillipines, in 7° of N. Lat., *Amphiura squamata*, decidedly cosmopolitan, being found in the northern seas, in the equatorial Atlantic, off the Cape of Good Hope, and New Zealand, and *Ophionereis shayeri*, which was usually considered peculiar to the southern coasts of Australia and New Zealand, but which really possesses a much wider range, being represented in the Museum at Paris by specimens from Cape Horn, and from the Galapagos Islands. The two remaining species have a more restricted distribution, *Amphiura constricta* being formerly only known from Port Jackson, and *Ophiactis lutkeni* only from Fernando-Po. The distribution of the latter is similar to that of *Ophionereis dubia*, which was formerly thought to be limited to the Indian Ocean, but recently has been found by Lyman Clark at Porto Rico.

The various collections made in Australia towards the end of last century showed that the littoral fauna of this vast land did not constitute a homogenous whole. While the fauna of the N. and N.E. coasts had a purely Indo-Pacific character, that of the S. and S.W. coasts was remarkable for including quite different species, allied to, or identical with, New Zealand species.

As regards the Echinoderms, J. Bell, in the Report upon the Voyage of the "Alert," has insisted on this important point, that the marine fauna of the tropical portions of Australia is that of the Indo-Pacific region, whilst that of the extra-tropical portions is of a New Zealand type. Lately Farquhar has arrived at similar conclusions. He is of the opinion that an Australian zoological region can be defined, the northern limit of which is bounded by the 25° of S. lat. (2 degrees more southerly than that of J. Bell), and which comprises all of Australia situated south of this line, together with New Zealand. The fauna of the Australian region thus defined has a character quite distinct from that of the portions of Australia situated N. of the 25° of S. lat. The latter portions should be included in the Indo-Pacific Region.

The result of the exploration of Michaelsen and Hartmeyer shows as far as the Ophiurids are concerned, that the fauna maintains its Indo-Pacific character all along the west coast of Australia—that is as far south as the 33rd parallel. This is much further south than on the east coast. The northern limit of the Australian-New Zealand region, therefore, on the west coast must be fixed much further south than was thought by J. Bell and Farquhar.

SYSTEMATIC LIST OF SPECIES.

Pectinura gorgonia (Lutken).—Turtle Island.
Ophioconis cupida (Koehler).—Shark Bay.
Ophiolepis annulosa (Muller and Troschel).—Turtle Island.
Ophioplocus imbricatus (Lyman).—Shark Bay.
Amphiura constricta (Lyman).—Shark Bay, Champion Bay, Cockburn Sound, Koombana Bay.
,, *squamata* (Sars.). Shark Bay, Fremantle Harbour, South Fremantle, Rottnest, Cockburn Sound, Oyster Harbour near Albany.
Ophiocnida aspera (Koehler).—Shark Bay.
,, *sexradia* (Duncan).—Shark Bay.
Ophiactis savignyi (Ljungmann).—Shark Bay.
Ophiactis lutkeni (Marktanner-Turneretscher).—Champion Bay, Gage Roads, near Fremantle.
Ophionereis dubia (Muller and Troschel). Shark Bay.
,, *shayeri* (Lutken).—Shark Bay.
Ophiocoma brevipes (Peters).—Shark Bay.
,, *scolopendrina* (Agassiz).—Shark Bay.
,, *wendtii* (Muller and Troschel).—Shark Bay.
Ophiacantha clavigera, n. sp. Cockburn Sound, Koombana Bay.
Ophiothrix hartmeyeri, n. sp. Shark Bay, Sunday Island.
Ophiothrix michaelseni, n. sp. Shark Bay, Koombana Bay.
,, *longipeda* (Mull. and Tros.). Turtle Island, Port Hedland, Houtman's Abrolhos Islands.
,, *hirsuta* (Mull. and Tros.).—Turtle Island, Port Hedland, Shark Bay.
,, *martensi* (Lutken).—Cossack.
,, *melanosticta* (Grube).—Port Hedland.
,, *propinqua* (Lyman.).—Shark Bay.
,, *striolata* (Grube).—South Fremantle, Cockburn Sound.
,, *stelligera* (Lyman.). Cossack, Onslow, Shark Bay, Cockburn Sound, Koombana Bay.
Ophiothela danae (Verrill.).—Shark Bay, Oyster Harbour near Albany.
Ophiomyxa australis (Lutken).—Shark Bay, Cockburn Sound, Warnbro Sound, Koombana Bay.
Astrophyton clavatum (Lyman.).—Shark Bay.

PART V.—PANORPATA and PLANIPENNIA.

By H. van der Weele, of Leyden.

Pp. 255-258, with 1 figure in the text.

The collection contains no new species. As the specimens were kept in spirit, the colours, which fade in drying, were well preserved.

PANORPATA.

Harpobittacus australis (Klug.). Baba Head (Edel Land), Serpentine, Brunswick, Yallingup.

PLANIPENNIA.

Family ASCALAPHIDAE.

Acmonotus incusifer (MacLachlan). Murchison district.
" *magnus* (MacLachlan).—N. of Subiaco.

Family MYRMELEONIDAE.

Of this family, richly represented in Australia only a single small larva was obtained at Yalgoo.

Family HEMEROBIIDAE.

Drepanepteryx humilis (MacLachlan). N. of Subiaco.

Family CHRYSOPIDAE.

Chrysopa sp. c.f. ramburi (Schneider). N. of Subiaco.

PART VI.—APIDAE.

By J. D. Alftken, of Bremen.

Pp. 259-261.

The examination of the small collection of bees leads the author to the conclusion that the systematic position of some of the genera must be altered. But this conclusion is only supported by the study of the males. A definite decision cannot be given until the unknown females have been found and examined.

Anthoglossa plumata (Smith).—Mundijong, Serpentine.

Halictus oblitus (Smith).—Serpentine.

Andrena advena (Smith).—Serpentine. It is possible, and in the author's opinion probable, that *A. infima* (Erichs) is the male of *A. advena* (Smith). Then Erichson's name would have priority.

Euryglossa halictiformis (Smith). Serpentine. The specimen seems to be a male of this species. Should this opinion prove erroneous, it might be considered as the type of a new species, *E. tarsata*. The genus *Euryglossa* should be placed in proximity to *Panurginus* (Nyl.).

Leioproctus frontalis (Smith). Denham. The genus *Leioproctus* too, must be placed in proximity to *Panurginus*.

Allodape grisea, n. sp.—Denham.

Exoneura pictifrons, n. sp. Mundijong. Some lighter coloured specimens are separated from the typical specimens, as var. *laeta*. It is scarcely probable that this species could be regarded as the still unknown male of *E. froggatti* (Friese.).

Apis mellifica, (L.)—The specimens belong partly to the forma typica, partly to the hybrid form *ligustica* (Spin.).

PART VII.—FORMICIDAE.

By Prof. A. Forel, of Chigny.

Pp. 263-310.

The collection contains 68 species. The author has also enumerated those species from S.W. Australia, which are not represented in this collection.

Sub-Family Ponerinae.

Amblyopone australis (Erichs). Bridgetown, Boyanup, Yallingup. Distributed throughout the whole of Australia.

,, *michaelseni*, n. sp.—Jarrahdale.

Myrmecia vindex (Smith). -Guildford, Fremantle, Serpentine, Bridgetown, Torbay. *M. nigriceps*, var. *ferruginea* (Mayr.) is identical with the typical form of this species.

,, *vindex*, var. *nigriceps* (Mayr.).—Jarrahdale, Boyanup, Gooseberry Hill, Broome Hill, King River.

,, *vindex*, var. *basirufa*, n. var.—.N of Subaico.

,, *forficata* (F.), subsp. *simillima* (Smith).—Boorabbin. Distributed over Tasmania and South Australia. *M. affinis* (Mayr) is identical with this form.

,, *nigriscapa* (Roger). –Bunbury. Widely distributed throughout Australia.

,, *sanguinea* (Smith).—Albany. Recorded from S. Australia.

,, *picta* (Smith). –N. of Subiaco. Already recorded from Fremantle and from Queensland.

,, *picta*, var. *nigra*, n. var.—East Fremantle.

,, *picta*, var. *infima* (Forel.).—Not present in the collection, is recorded from Perth.

,, *chasei* (Forel). Guildford. Formerly recorded from Perth.

,, *michaelseni*, n. sp.—King River, N.E. of Albany.

,, *fulvipes* (Roger). –A variety not present in the collection, is recorded from King George's Sound.

Ectatomma (*Rhytidoponera*) *punctatum* (Smith). –East Fremantle. Jarrahdale. Specimens from Fremantle are in the author's collection. Smith's specimens are from Port Lincoln, South Australia.

,, *punctatum*, subsp. *aciculatum* (Smith). –Yalgoo. The type is from the Hunter River, New South Wales.

,, *mayri* (Emery), subsp. *glabrius*, n. subsp.—Day Dawn, Yalgoo.

,, *convexum* (Mayr.). subsp. *violaceum*,n. subsp.—Northampton, Eradu, Wooroloo, Lion Mill, Mundaring Weir, South Perth, N. of Subiaco, Jarrahdale, York. The typical form of this species is found in Queensland.

Ectatomma convexum, var. *gemma*, n. var. Yarloop, Gooseberry Hill, York.

,, *metallicum* (Smith). Northampton, Kalgoorlie, Coolgardie, Wooroloo, Lion Mill, Mundaring Weir, N. of Subiaco, Serpentine, Bridgetown. Distributed throughout the whole of Australia.

,, *metallicum*, var. *modesta* (Emery). -Fremantle, Bunbury. Formerly recorded from Queensland.

,, *crassinode*, n. sp.—Day Dawn.

Euponera (*Brachyponera*) *lutea* (Mayr.). Lion Mill, Mundaring Weir, Yarloop, Bunbury, Donnybrook. Distributed throughout the whole of Australia.

Pachycondyla (*Bothroponera*) *piliventris* (Smith), subsp. *regularis*, n. subsp.—Tamala in Edel Land. Perhaps one might be justified in creating a new species for this form.

Leptogenys (*Lobopelta*) *neutralis*, n. sp.—Pickering Brook.

,, *fallax* (Mayr.). Not in the present collection. An example of this species, which is distributed over the whole of Australia, was sent to the author from the Adelaide River, W. Australia.

Odontomachys ruficeps (Smith), f. typica. Yalgoo. Formerly recorded from Australia, but without any information about the exact locality. Various subspecies and varieties are known from Queensland.

Sphinctomyrmex froggatti (Forel). subsp. *imbecilis*, n. subsp.—Lion Mill. The typical form of this species was found in New South Wales. It remains an open question as to whether this new form should be regarded as a subspecies of *S. froggatti* or as a separate species.

Sub-Family DORYLINAE.

This sub-family is not represented in the collection.

Sub-Family MYRMICINAE.

Meranoplus dichrous, n. sp.—Yalgoo.

Tetramorium guineense (F.).—South Perth. A cosmopolitan species.

,, (*Xiphomyrmex*) *viehmeyeri*, n. sp.—Day Dawn.

Dacryon liber, n. sp.—Eradu.

Podomyrma bimaculata (Forel).—Moora, Boorabbin. Formerly recorded from Kalgoorlie and New South Wales.

Monomorium sydneyense (Forel).—Denham. Previously recorded from New South Wales.

,, *bicorne*, n. sp.—Gooseberry Hill.

,, (*Martia*) *ilia*, n. sp.—Day Dawn, Guildford. This form may perhaps be only a subspecies of *M. laeve* (Mayr) from Queensland.

Solenopsis belisarius, n. sp.—Northampton. The first species of the genus *Solenopsis* found in Australia.

Cremastogaster laeviceps (Smith) var *chasei* (Forel). –Dirk Hartog, N. of Subiaco, Karrakatta, Bunbury. While the typical form of this species is distributed over the whole of Australia, this variety was formerly only recorded from Perth.

" *frivola* (Forel).—Geraldton. Formerly recorded from Kalgoorlie.

" *frivola*, var. *sculpticeps*, n. var.—Kalgoorlie.

Pheidole variabilis (Mayr.) subsp. *latigena*, n. subsp. –Day Dawn. The typical form and the other subspecies of this species are found in Eastern Australia.

" *ampla* (Forel), f. typica. Tamala (Edel Land), Gooseberry Hill. The typical form of this species was formerly found on the East Wallaby Island (Houtman's Abrolhos). Different varieties are living in Victoria, New South Wales and Queensland.

" *bos* (Forel), f. typica.—Albany. First found at Fremantle; afterwards rediscovered in Victoria.

" *hartmeyeri*, n. sp. Buckland Hill near Fremantle, Broome Hill.

" *froggatti* (Forel). – Moora, Lion Mill, .N of Subiaco, Boyanup, Gooseberry Hill, Torbay. Formerly found at Kalgoorlie. *P. myops* (Forel) from Native Dog Bore (550 miles west of Sydney, that is near the border between New South Wales and South Australia) is identical with this species.

Stenamma (*Ichnomyrmex*) *longiceps* (Smith). Dongarra, Gooseberry Hill. Distributed throughout the whole of Australia.

Sub-Family DOLICHODERINAE.

Dolichoderus ypsilon (Forel). Lion Mill, Guildford, N. of Subiaco, East Fremantle, Cannington, Harvey, Gooseberry Hill. Formerly known from Perth, and described as *D. scabridus* (Roger), subsp. *ypsilon*.

" *clusor*, n. sp.—Fremantle.

Tapinoma minutum (Mayr.). –Midland, Donnybrook. Distributed throughout the whole of Australia.

" (*Doleromyrmex*) *darwinianum* (Forel), var. *fida*, n. var. —Guildford, Collie, Bunbury, Bridgetown, Donnybrook, Boyanup, Pickering Brook. The typical form of this species is found at Mount Victoria, in New South Wales.

Bothriomyrmex pusillus (Mayr.).. subsp. *aequalis* (Forel).—Busselton. Distributed throughout the whole of Australia. This form was formerly described as var. *aequalis*, but it is better to regard it as a subspecies.

Iridomyrmex punctatissimus (Emery).—Denham, Dirk Hartog, Lion Mill, East Fremantle. Distributed throughout the whole of Southern Australia.

,, *nitidus* (Mayr.).—Guildford. Common over the whole of Australia.

,, *nitidus*, var. *queenslandensis* (Forel).—Moora, Guildford, Cranbrook, Harvey, King River (near Albany). Recorded from Queensland.

,, *chasei* (Forel).—Geraldton, Day Dawn, Moonyoonooka, Gingin, Fremantle, Boyanup. Previously discovered at Perth, and known only from S.W. Australia.

,, *chasei* (Forel), var. *yalgooensis*, n. var.—Geraldton, Day Dawn, Yalgoo, Coolgardie. This variety is quite inconstant.

,, *chasei* (Forel), subsp. *concolor* (Forel).—Dirk Hartog, Geraldton, Coolgardie, Buckland Hill near Fremantle, East Fremantle, Rottnest. This subspecies was formerly described as var. *concorol.*

,, *mattiroloi* (Emery), var. *splendens*, n. var.—Donnybrook, Albany. The typical form of this species was found in Tasmania.

,, *bicknelli* (Emery).—Yalgoo, Coolgardie, Mundaring Weir, Bunbury, Donnybrook. Previously recorded from New South Wales and Tasmania.

,, *bicknelli*, var. *splendida* (Forel).—Lion Mill, Mundaring Weir, N. of Subiaco, North Fremantle, Yarloop. Already recorded from S.W. Australia by Chase.

,, *bicknelli*, subsp. *brunneus* (Forel).—Eradu. Previously recorded from Kalgoorlie.

,, *rufoniger* (Lowne), subsp. *suchieri*, n. subsp.—Day Dawn, Yalgoo, Eradu, Dongarra, Wooroloo, N. of Subiaco.

,, *itinerans* (Lowne), subsp. *nitidiceps* (André).—Torbay, Albany. This subspecies is already recorded from Victoria and South Australia.

,, *itinerans*, subsp. *perthensis* (Forel).—Which is not present in the collection, was found at Perth by Chase.

,, *innocens*, n. sp.—Yalgoo, Lion Mill, Midland, Yarloop,

,, *discors* (Forel), subsp. *occipitalis*, n. subsp.—Northampton.

,, *discors*, subsp. *occipitalis*, var. *exilior*, n. var.—Northampton, N. of Subiaco. The typical form of this species was found at Charters Towers, Queensland, and a variety, *obscurior* (Forel) at Ballarat, Victoria.

Iridomyrmex agilis, n. sp.—Yalgoo.

,, *hartmeyeri*, n. sp.—Day Dawn.

,, *exsanguis*, n. sp.—Denham.

,, *detectus* (Smith).—Northampton, Moora, Kalgoorlie-Boyanup. Distributed over the whole of Australia.

,, *conifer* (Forel).—Lion Mill, N. of Subiaco, East Fremantle, Jarrahdale, Bunbury, Bridgetown, Pickering Brook, Formerly recorded from Perth.

Sub-Family CAMPONOTINAE.

Acantholepis (*Stigmacros*) *aemula*, n. sp.—Fremantle.

Notoncus gilberti (Forel), var *gracilior*, n. var.—Fremantle. The typical form of this species is found in Queensland. Perhaps this new variety should be regarded as a subspecies.

Opisthopsis respiciens (Sm.).—This species is not among the ants of the present series, but in the author's collection are specimens from the Baudin Islands, and the Adelaide River, in South-Western Australia.

Camponotus maculatus (F.), subsp. *novae-hollandiae* (Mayr.).—Torbay. Distributed over the whole of Australia.

,, *matulatus*, subsp. *discors* (Forel).—Yalgoo, Coolgardie. The typical form of this species was found at the Pera Bore, New South Wales.

,, *maculatus*, subsp. *discors*, var. *angustinota*, n. var.—Denham, Day Dawn, Kalgoorlie, Wooroloo, Mundaring Weir.

,, *walkeri* (Forel).—Guildford. Formerly recorded from Perth and from the Baudin Islands, in S.W. Australia.

,, *claripes* (Mayr.).—Bridgetown. Distributed over the whole of Australia.

,, *claripes*, subsp. *marcens*, n. subsp.—Mundaring Weir, Guildford.

,, *testaceipes* (Smith).—Eradu, Lion Mill, Mundijong, Yarloop, Collie, Bunbury, Gooseberry Hill, Cranbrook. Also known from New South Wales.

,, *nigriceps* (Smith).—Broome Hill. Distributed over the whole of Australia.

,, *nigriceps*, var. *dimidiata* (Roger).—Mundaring Weir, Gooseberry Hill. Distributed over the whole of Australia.

,, *nigriceps*, subsp. *obniger* (Forel), var. *prostans*, n. var. —Lion Mill, Jarrahdale, Lunenburg, Pickering Brook, Torbay, King River. The subspecies *obniger* is found in South Australia.

,, *arcuatus* (Mayr.), var. *aesopus*, n. var.—Mount Robinson, near Kalgoorlie. The typical form of this species occurs in Queensland.

Camponotus cinerus (Mayr.).—Coolgardie. Previously recorded from Queensland.
,, *cinerus*, subsp. *notterae*, n. subsp. Gooseberry Hill.
,, *ephippium* (Smith). Eradu. Already recorded from Queensland, New South Wales, Adelaide, etc.
,, *michaelseni*, n. sp.—Mundaring Weir, Jarrahdale, Gooseberry Hill, Pickering Brook.
,, *scratius*, n. sp. Buckland Hill near Fremantle, Fremantle.
,, *scratius*, var. *nuntius*, n. var.—Dirk Hartog.
,, *molossus*, n. sp.—Buckland Hill, near Fremantle, Serpentine. Perhaps this form may be simply a subspecies of *C. intrepidus* (Kirby).

The following species of *Camponotus* not present in this collection are also recorded from S.W. Australia :—

Camponotus gibbonatus (Forel). Kalgoorlie.
,, *insipidus* (Forel).—Wallaby Island, Houtman's Abrolhos.
,, *wiederkehri* (Forel). Kalgoorlie. Also recorded from Charters Towers, Queensland.
,, *lownei* (Forel). Perth. Also recorded from Mackay, Queensland.
,, *capito* (Mayr.). Kalgoorlie. Also recorded from Peak Downs, Queensland.
,, *subnitidus* (Mayr.).—Fremantle. Also recorded from Queensland, etc.
,, *crenatus* (Mayr.).—Fremantle. Also recorded from Rockhampton, Queensland.
,, *purpureus* (Mayr.). -Kalgoorlie. Also recorded from Queensland.

Polyrhachis chalcas, n. sp. Denham, Geraldton, Dongarra.
,, *micans* (Mayr.), subsp. *ops*, n. subsp. Albany. The typical form of this species is found in Queensland.

The following species of *Polyrhachis* not present in the collection are also recorded from S.W. Australia :—

Polyrhachis terpsichore (Forel). S.W. Australia.
,, *ammonoeides* (Forel). -S.W. Australia and Queensland.
,, *trapezoidea* (Forel). -S.W. Australia and other parts of Australia.
,, *aurea* (Forel). S.W. Australia and other parts of Australia.

GEOGRAPHICAL RELATIONS. The difference between the ants of S.W. Australia and those of the other parts of Australia is striking. There are 32 species which are found only in S.W. Australia, while 36 are also found in other parts of the Continent. Twelve species are represented in S.W. Australia by particular subspecies and only 4 S.W. Australian subspecies are met with in other parts of Australia. As for the varieties only 6 of the 21 from S.W. Australia are found elsewhere in Australia.

PART VIII.—DYTISCIDAE, GYRINIDAE, and HYDROPHILIDAE.

By Dr. M. Regimbart, of Evreux.

Pp. 311-316.

To the list and the descriptions of the S.W. Australian water-beetles the author has added the description of a new species from Tasmania and Victoria, viz., *Philhydrus persimilis.* The following list enumerates the species of the present collection.

DYTISCIDAE.

Necterosoma penicillatum (Clark).—Rottnest in a salt lake; in the Avon, Beverley.

Antiporus femoralis (Boh.).—Busselton, in the Vasse; Albany, in a freshwater lagoon.

Macroporus howitti (Clark).—Monger's Lake.

,, *dilatatus*, n. sp.—Monger's Lake.

Paroster michaelseni, n. sp.—Boorabbin, in a small freshwater pool on the top of a granite rock.

Bidessus bistrigatus (Clark).—Yalgoo, in pools in the almost dried bed of a small creek.

,, *biformis* (Sharp).—Albany, in a freshwater pool.

,, *shuckardi* (Clark).—Broome Hill, in a stream.

Rhantus pulverosus (Steph.), var. *australis* (Aubé) = *conspersus* (Gyll.).—Monger's Lake.

,, *simulans*, n. sp.—Albany, in a freshwater pool. A specimen in the author's collection at the British Museum is from the Swan River.

Hyderodes shuckardi (Hope).—Northampton, in a stream; Eradu, in a pool in the nearly dried up bed of the Greenough River.

Cybister tripunctatus (H.).—Monger's Lake.

GYRINIDAE.

Macrogyrus angustatus (Reg.).—Jarrahdale, in calmer oxbows of a stream; Pinjarrah, in the Murray River; Serpentine, in the Serpentine River; Brunswick, in a small stream.

HYDROPHILIDAE.

Hydrotrephis mastersi (Macl.).—Monger's Lake; Mundijong, in the water of a trench; Bunbury, in a freshwater pool. This species may be the same as *Hydrophilus semicylindricus* (Eschsch.), from the Sandwich Islands.

Hydrobius hartmeyeri, n. sp.—Gooseberry Hill, in a small stream.

Helochares tenuistriatus, n. sp.—Monger's Lake.

Philhydrus temporalis, n. sp.—Beverley, in the Avon.

Paracymus nitidiusculus (Brown). -Brunswick, in a stream; Gooseberry Hill, in a small stream.

Berotus munitipennis (Blackb.). -Kalgoorlie, in a dam containing brackish water in the dried bed of Hannan's Lake.

Berotus australiae (Muls.). -Pinjarrah, in the Murray River. Perhaps this specimen should be regarded as *B. gravis* (Blackb.).

Cyclonotum australe (Blackb.). Monger's Lake.

PART IX. -BRACONIDAE and ICHNEUMONIDAE.

BY GY. SZEPLIGETI, OF BUDAPEST.

Pp. 317-324, with 2 figures in the text and a part of Plate III.

There are only 9 species in the collection, all of them new. Three require the creation of new genera, two the creation of new sub-families.

BRACONIDAE.

Sub-Family BRACONINAE.

Bracon hartmeyeri, n. sp. -N. of Subiaco.

Sub-Family EXOTHECINAE.

Xenarcha tricolor, n. sp.—Denham.

Opiopterus parvus, n. gen., n. sp. -Dirk Hartog, Brown Station.

Sub-Family CHELONINAE.

Ascogaster abdominalis, n. sp.—Yalgoo.
,, *antennalis*, n. sp.—Serpentine.

ICHNEUMONIDAE.

Sub-Family OPHIONINAE.

Allocamptus bituberculatus, n. sp. Serpentine.

Sub-Family nov. ORTHOGNATHELLINAE.

Orthognathella superba, n. gen., n. sp. Mundijong.

Sub-Family METOPIINAE.

Metopius michaelseni, n. sp. Dirk Hartog, Brown Station.

Sub-Family nov. MEGACERINAE.

Megaceria opheltes, n. gen., n. sp.—Donnybrook.

PART X. -TENEBRIONIDAE.

BY H. GEBIEN, OF HAMBURG.

Pp. 325-348, with 4 figures in the text and a part of Plate III.

The collection is rather rich in species, a great number of which are new. As very many species are already known from Western Australia, and only a few of these occur in the collection, it must be assumed that our knowledge of Western Australian

Tenebrionids is relatively poor. It may be gathered from the study of the present collection that the Western Australian Tenebrionids are completely different from those of Eastern and Southern Australia. Of all the species in the collection only *Helaeus perforatus* and *Pterohelaeus granulatus* are known from S. Australia. *Micrectyche* and *Ectyche*, as well as the new genus *Aglypta*, are restricted to Western Australia.

Cestrinus puellus, n. sp.—York.
,, *costatus*, n. sp.—York.
Gonocephalum walkeri (Champ.).—Northampton, Geraldton, Fremantle, Bunbury.
Platydema abdominale, n. sp.—Torbay.
Alphitobius diaperinus (Panz.).—Coolgardie (cosmopolitan), introduced.
Pterohelaeus parallelus (Breme). East Fremantle. Already recorded from Western Australia.
,, *granulatus* (Grm.).—Day Dawn. Recorded from Eastern Australia.
,, sp. dub.—Dongarra, Kalgoorlie, Coolgardie, Boorabbin.
Helaeus perforatus (Latr.).—N. of Subiaco. Recorded from S. and W. A.
Saragus subrugosus (Br.).—Denham, Rottnest.
,, *brunnipes* (Bsd.).—Albany (the commonest Tenebrionid of Western Australia).
Aglypta octocostata, n. gen., n. sp.—Day Dawn.
Hypaulax orcus (Pasc.).—Kalgoorlie, Boorabbin.
Omolipus chalybeus, n. sp.—Boyanup.
,, *affinis*, n. sp.—Tamala.
,, *parvus* (Bates).—East Fremantle.
Chalcopterus michaelseni, n. sp.—Eradu.
,, *parallelocollis*, n. sp.—Eradu.
,, *hartmeyeri*, n sp.—Mount Robinson, near Kalgoorlie.
,, *minor* (Blackb.).—Northampton, Eradu.
,, *interrogationis*, n. sp.—Day Dawn.
,, *bicolor*, n. sp.—W. Australia (in the author's collection).
,, *blackburni*, n. sp—W. Australia (in the author's collection.)
,, *tenuicornis*, n sp.—W. Australia (in the author's collection).
,, *yorkensis* (Bl.).—Northampton.
Micrectyche ferruginea (Bates).—Guildford, Fremantle, Rottnest. Harvey
Ectyche sculpturata (Bates).—Lion Mill, Guildford, N. of Subiaco
Dystalica parallela (Lea).—Tamala, Day Dawn.
Adelium tralaticium, n. sp.—Mount Robinson, near Kalgoorlie.
,, *forticorne*, n. sp.—Torbay, Albany.

Adelium breviusculum, n. sp.—Tamala.
,, sp. dub.

PART XI.—ALLECULIDAE.

By F. Borchmann, of Hamburg.

Pp. 349-358, with 4 figures in the text, and a part of Plate III.

The present collection contains only 4 species of Alleculidae, all of which are new, and which do not readily conform with any known genus. The author adds to the descriptions of these new species those of two new species in his own collection.

Homotrysis grandis, n. sp.—W. Australia (in the author's collection).
,, *obscura*, n. sp.—W. Australia (in the author's collection).
Dimorphochilus apicalis, n. gen., n. sp.—Torbay.
,, *diversicollis*, n. sp.—Northampton, Day Dawn, Yalgoo, Eradu, Kalgoorlie, Boorabbin, Cranbrook.
,, *sobrinus*, n. sp.—Dirk Hartog, Brown Station.
Oocistela convexa, n. gen., n. sp.—Fremantle.

PART XII.—ARANEAE.

Section I.

By Eugene Simon, of Paris.

Pp. 359-446, with 14 figures in the text (Introduction in French, main part in Latin).

The Aranean fauna of Western Australia has certain characteristics in common with those of other parts of the Continent. Some typical species: *Delena cancerides* (Walck.), *Nicodamus bicolor* (L. Koch.), etc., are as common here as elsewhere throughout Australia.

Other very distinctive groups, *Hemicloea*, *Lampona*, *Isopoda*, etc., are equally rich in W.A., but generally represented by other species. Among the Homocloeinae we have to note the new genus *Corimaethes*, which is closely related to *Platyoides*, of South Africa, the only genus of the group outside of Australia. In the family Avicularidae the new genus *Proshermacha* also very much resembles the South African genus *Hermacha*, and the genus *Synothele*, the genus *Cestotrema* of Madagascar.

On the other hand, we do not find in Western Australia the affinities to the Malayan fauna, which are so numerous in Queensland, and especially at Cape York, in the North.

Here follow various notes concerning systematic and biological relations of which only the latter are of general interest.

The spiders of the new genus *Phryganoporus* differ from the allied typical *Amaurobius* not only in peculiarities of structure but also in some of their habits. They are sociable like *Stegodyphus gregarius* (Cambr.), and *S. sarasinorum* (Karsch.), and the genus *Diguetia*. A great number of individuals unite in order to spin in common, on the twigs of shrubs, a large dome of a very dense tissue, fixed and closed above, free below, and supported by diverging threads. There are in the collection several examples of these curious structures.

According to a note of the collector, *Latrodectus hasselti* (Thorell) is feared throughout W.A. for its poison, and regarded just as dangerous as in the Eastern States of Australia and New Zealand.

The few species known from W.A. and not represented in the present collection are enumerated together with those included therein. In consequence, the paper gives a complete list of the Western Australian spiders known at the present time.

Family AVICULARIIDAE.

Sub-Family CTENIZINAE.

CYRTAUCHENIEAE.

Cantuaria hoggi, n. sp.—Eradu.

NEMESIEAE.

Proshermacha tigrina, n. gen., n. sp.—Jarrahdale, Serpentine.
,, *subarmata*, n. sp.—Wooroloo, Harvey.

Sub-Family BARYCHELINAE.

DIPLOTHELEAE.

Synothele michaelseni, n. gen., n. sp.—Lion Mill.

BARYCHELEAE.

Idiommata sp ? (*I. blackwalli*, Cambr. ?). -Mundaring Weir.

Sub-Family DIPLURINAE.

Palaevagrus fugax, n. gen., n. sp. Geraldton, Lion Mill.

Besides these species of the Family Aviculariidae, the following are known from Western Australia: *Missulena* (*Eriodon*) *granulosa* (O. P. Cambr.), *M.* (*E.*) *crassa* (P. O. Cambr.), *Idiosoma sigillatum* (O. P. Cambr.), *Idiommata blackwalli* (O. P. Cambr.), *Missulena occatoria* (Walcken) (teste Hogg), *Anidiops manstridgei* (Pocock), *Eucyrtops latior* (O. P. Cambr.), *Selenocosmia stirlingi* (Hogg), *Aganippe occidentalis* (Hogg). [Note.—The author mentions *Stenigrocercus broomi* (Hogg) as being a possible species of *Palaevagrum*, n. gen., but without noting its locality. The writer concludes from the name of this species that it also may be Western Australian—from Broome ?'';

Family DICTYONIDAE.

Amaurobius robustus (L. Koch).—Northampton, Moora, Kalgoorlie, Subiaco, East Fremantle, York, Cranbrook.
,, *microps*, n. sp.—Bridgetown, Albany.

Phryganoporus gausapatus occidentalis, n. gen., n. subsp.—Cannington.
,, *tubicola*, n. sp.—Denham.
,, *nigrinus*, n. sp.—Boyanup.
Aphyctoschaema virgosum, n. sp. Kalgoorlie, Coolgardie.
,, *armigerum*, n. sp.—Northampton, Day Dawn, Eradu, Watheroo, Moora, North Fremantle, Yarloop.
,, *storeniforme*, n. sp.—Day Dawn.
,, *veliferum*, n. sp.—Dirk Hartog, Brown Station.
,, *vultuosum*, n. sp.—Eradu, Moonyoonooka, Wooroloo, Cannington.
,, *albicauda*, n. sp.—Eradu.
,, *bivittatum*, n. sp.—Dongarra.
,, *cryphoeciforme*, n. sp.—Kalgoorlie, Guildford.
Syrorisa seriata, n. gen., n. sp.—Yalgoo.
Epimecinus tegenarioides, n. gen., n. sp.—Collie.
,, *volucripes*, n. sp. Rottnest, Jarrahdale, Brunswick, Bunbury.
Lathyarcha tetrica, n. gen., n. sp.—Boyanup.
Callevophthalmus lividus, n. sp.—Buckland Hill, East Fremantle.
Dictyna anaulax, n. sp.—Cottesloe.

Family ULOBORIDAE.

Of this family, not represented in the present collection, only *Dinopis unicolor* (L. Koch) is recorded from W.A.

Family OONOPIDAE.

Gamasomorpha servula, n. sp.—Eradu.

Family DYSDERIDAE.

Ariadna thyrianthina, n. sp.—Baba Head and Tamala (Edel district), Norseman, Albany.

Family DRASSIDAE.

Sub-Family Hemicloeinae.

Rebilus castaneus, n. sp.—Tamala, Day Dawn, Yalgoo, Mount Robinson (near Kalgoorlie).
Hemicloea insidiosa, n. sp.—East Fremantle, N. of Subiaco.
,, *michaelseni*, n. sp.—Yalgoo, Karrakatta.
,, *sublimbata*, n. sp. Kalgoorlie, Coolgardie, Boorabbin, Beverley; also recorded from Victoria (E. Simon's collections).
,, *crocotila*, n. sp.—Northampton.
,, *semiplumosa*, n. sp.—Boorabbin, Cranbrook.
Corimaethes campestratus, n. gen., n. sp. Day Dawn.

Sub-Family Drassodinae.

Drassodeae.

Drassodes respersus, n. sp.—Northampton.

Drassodes petilus, n. sp.—Fremantle, Bunbury.
,, *nugatorius*, n. sp.—Albany, also found in Victoria.
,, *micaceus*, n. sp.—Dongarra.
,, *musteculus*, n. sp.—Boyanup.

Here follow the descriptions of two species, *D. sarritus*, n. sp., from Tasmania, and *D. dimotus*, n. sp., from Victoria (in the author's collection).

Homoeothele micans, n. gen., n. sp.—Denham, Moonyoonooka.

Another species of this section, *Melanophora* (*Prosthesima*) *flavens* (L. Koch), not represented in the present collection, is recorded from Swan River.

Section II.

GNAPHOSOIDEAE.

Gnaphosoides albopunctata (R. H. Hogg).—Coolgardie.

ECHEMEAE.

Megamyrmaecion penicillatum, n. sp.—Yalgoo, Boorabbin, Wooroloo. Guildford, Collie, Brunswick, York, Torbay.
,, *vestigator*, n. sp.—Mount Robinson (near Kalgoorlie).
,, *austrinum*, n. sp.—Geraldton.
,, *echemophthalmum*, n. sp.—Pickering Brook, York.
,, *perpusillum*, n. sp.—Tamala, Wooroloo.
Aphantaulax scotophaeus, n. sp.—Boyanup.
Sergiolus australianus, n. sp.—Northampton.

LAMPONEAE.

Lampona punctigera, n. sp.—Northampton, Moora, Lion Mill, Midland, Karrakatta, East Fremantle, Harvey, York, Torbay.
,, *foliifera*, n. sp.—Boorabbin.
,, *obnubila*, n. sp.—Boyanup.
,, *cylindrata* (L. Koch).—Northampton, N. of Subiaco, East Fremantle, Boyanup, Torbay; previously recorded from Victoria.
,, *paupercula*, n. sp.—Boyanup.
,, *quinqueplagiata*, n. sp.—Dirk Hartog, Brown Station, Boyanup.

Lampona brevipedi (L. Koch) has been recorded from the Swan River.

Family ZODARIIDAE.

Storena tetrica, n. sp.—Albany.
,, *torosa*, n. sp.—Northampton.
,, *eximia*, n. sp.—Kalgoorlie, Boorabbin.
,, *tricolor*, n. sp.—Lion Mill, Collie, Boyanup.

Family HERSILIIDAE.

Tama brachyura, n. sp.—Geraldton, Karrakatta, East Fremantle, Brunswick, Boyanup.

Family PHOLCIDAE.

Pholcus phalangioides (Fuessly).—Denham, Geraldton ; found in all temperate regions.

Trichocyclus nigropunctatus, n. gen., n. sp.—Yalgoo.

Family THERIDIIDAE.

MONETEAE.

Moneta longicauda, n. sp.—N. Subiaco.

EURYOPEAE.

Euryopis elegans (Keyserling).—Northampton (previously recorded from Peak Downs, in Queensland).

,, *maga*, n. sp.—Torbay.

THERIDIEAE.

Theridion extrilidum (Keyserling). Guildford, N. Subiaco, E. of Cannington, Yallingup, Torbay ; recorded from Eastern Australia.

,, *mortuale*, n.s p. –N. Subiaco, Harvey, Collie, Boyanup.

,, *subpingue*, n. sp.—Jarrahdale, Boyanup.

,, *hartmeyeri*, n. sp.—Moora.

DIPOENEAE.

Dipoena (*Lasacola*) *austera*, n. sp. Denham.

Latrodectes hasselti (Thorell). Geraldton, Day Dawn, Eradu, Moonyoonooka, Dongarra, Watheroo, Mount Robinson (near Kalgoorlie), Kalgoorlie, Boorabbin, Wooroloo, Lion Mill, Mundaring Weir, N. of Subiaco, East Fremantle, Fremantle, Rottnest, Harvey, Boyanup, York, Beverley ; recorded from all parts of Australia, from New Zealand, and South Asia as far west as Eastern Arabia.

ASAGENEAE.

Crustulina bicruciata, n. sp.—Eradu.

Teutana grossa (L. Koch).—Dongarra, Fremantle (in houses and gardens) ; found in nearly all warm regions.

,, *adumbrata*, n. sp.—Yalgoo.

Lithyphantes niveo-signatus, n. sp. -Denham, Eradu.

,, *octonotatus*, n. sp.—Day Dawn.

Enoplognatha bidens, n. sp. Eradu, Fremantle, York, Broome Hill.

Family ARGIOPIDAE.

Sub-Family LINYPHIINAE.

ERIGONEAE.

Delorrhipis erythrocephalus, n. sp. -North Fremantle.

Gonatium (?) *lividulum*, n. sp.—Torbay.
Ceratinopsis melanura, n. sp.—Fremantle.

LINYPHIEAE.

Linyphia cupidinea, n. sp.—N. of Subiaco.
Laetesia mollita, n. gen., n. sp.—Bunbury, Boyanup.
,, *egregia*, n. sp.—Eradu.

Sub-Family TETRAGNATHINAE.

Tetragnatha luteo-cincta, n. sp.—Midland, Guildford, Serpentine, Brunswick.
,, *maeandrata*, n. sp.—N. of Subiaco, Serpentine, Albany.
Nanometa gentilis, n. gen., n. sp.—Lion Mill, Yallingup, Broome Hill, South Albany.

Sub-Family NEPHILINAE.

Nephila imperatrix (L. Koch).—Denham, Boorabbin; distributed throughout the whole of Australia.

Sub-Family ARGIOPINAE.

ARGIOPEAE.

Argiope trifasciata (Forsköl).—Boorabbin; found in nearly all tropical and sub-tropical regions.
,, *protensa* (L. Koch).—Boorabbin; recorded from Eastern Australia and New Zealand.
Gea theridioides (L. Koch).—Midland, East Fremantle; recorded from Eastern Australia.

CYCLOSEAE.

Cyclosa bacilliformis, n. sp.—Lion Mill.

MANGOREAE.

Larinia eburneiventris, n. sp.—Dirk Hartog, Brown Station, N Fremantle.

ARANEAE.

Araneus senicaudatus, n. sp.—Northampton, Leederville, Rottnest, Jarrahdale, Serpentine.
,, *senicaudatus simplex*, n. subsp.—Lion Mill, Midland, N. Subiaco, Leederville, Cottesloe, E. Fremantle, Brunswick, Beverley.
,, *cyphoxis*, n. sp.—Perth, Rottnest, Brunswick.
,, *amblycyphus*, n. sp.—Busselton.

Besides these species, *Araneus* (*Epeira*) *necospina* (Keyserling) is recorded from W.A.

GASTEROCANTHEAE.

Gasternacantha minax (Thorell).—Northampton.

ANEPSIAE.

Paraplectanoides cerula, n. sp.—Dirk Hartog, Brown Station.

CELAENIEAE.

Celaenia dubia (Cambr.).—N. Fremantle.

Besides this species of the Celaenieae, *Poltys salebrosus* (Rainbow) is found at Fremantle.

ARCYEAE.

Arcys nitidiceps, n. sp.—Torbay.

DOLOPHONEAE.

Dolophones conifer (Keyserling). Dirk Hartog, Brown Station.

THERIDIOSOMATEAE.

Billima attrita, n. gen., n. sp.—N. Subiaco.

Family THOMISIDAE.

Sub-Family MISUMENINAE.

Bomis larvata (L. Koch). Dirk Hartog, Brown Station; recorded from Eastern Australia.

Tharpyna campestrata (L. Koch).—Day Dawn, Yalgoo, Coolgardie, Boorabbin, Guildford, S. and N. Subiaco, Brunswick.

Xysticus periscelis, n. sp. Perth, N. Subiaco, Fremantle.

Besides these, *Diaea olivacea* (L. Koch) and *D. multimaculata* (Rainbow) are recorded from W.A.

Sub-Family STEPHANOPSINAE.

Stephanopsis cabridgei (Thorell). Eradu, S. Subiaco, Yarloop; recorded from Eastern Australia.

,, *palliolata*, n. sp.—Wooroloo.

Sidyma trapezia (L. Koch).—Karrakatta; recorded from East Australia. W

,, *kochi*, n. sp.—North Fremantle.

Family CLUBIONIDAE.

Sub-Family SPARASSINAE.

DELENEAE.

Delena cancerides (Walckenaer).—Geraldton, Moonyoonooka, Boorabbin, East Fremantle, York, South Albany. Found throughout Australia and Tasmania, and confined to the Commonwealth.

Eodelena nigrifrons, n. sp.—Boorabbin.

Another species of this group, *Zachria flavicoma* (L. Koch), is recorded from King George's Sound.

Isopoda insignis (Thorell). Shark Bay district, Mount Robinson (near Kalgoorlie). Spread over W. and S. Australia.

,, *woodwardi*, n. sp.—Kalgoorlie.

,, *nigrigularis*, n. sp.—Tamala, Northampton.

,, *leishmanni* (Hogg).—Boorabbin, S. and N. Subiaco, Fremantle, Yarloop, Harvey, Lunenberg, Boyanup, Torbay. Previously recorded from Albany.

,, *leishmanni hoggi*, n. subsp.—Midland.

Isopoda cerussata, n. sp.—Northampton.
,, *cana*, n. sp.—Cranbrook.

Besides these, *Isopoda pingellya* (Hogg) is found in W.A., at Pingelly, and in the Darling Ranges; and *I. sundersi* (Hogg) on the Chapman River.

Pediana tenuis (Hogg).—Day Dawn.

Besides this species, *P. occidentalis* (Hogg) is recorded from W.A.

Olios calligaster (Thorell).—Denham, Broome Hill. Spread over nearly the whole continent.

Besides this species, *O. pictus* (L. Koch) and *O. diana* (L. Koch) are also found in W.A.

HETEROPODEAE.

Heteropoda regia (Fabricius).—W.A., Murchison district (?). In the collection of the W.A. Museum. Spread over all tropical regions.

Sub-Family MOLYCRIEAE, n. subfam.

Myandra bicincta, n. sp.—Boyanup.
Molycria splendida, n. sp.—Northampton.
,, *flavipes*, n. sp.—East Fremantle.
,, *alboplagiata*, n. sp.—Lion Mill.
Honunius quadricauda, n. gen., n. sp.—Harvey.

PART XIII.—FOSSORES.

By W. A. Schulz, of Geneva.

Pp. 447-488, with three figures in the text.

The collection of Fossores from W.A. is only small, containing not more than thirteen species. Of these species six are new. Two of these, *Nitela australiensis* and *Lyroda michaelseni*, belong to genera which had not been previously recorded from Australia. Two other species, both Thynnids, are probably restricted to the South-West of this continent.

The previously described species of the collection are no less interesting. *Dimorphoptera unicolor* (F. Sm.), *Cryptochilus* (*Prionocnemis*) *tuberculatus* (F. Sm.), and *Larra* (*Notogonia*) *chrysonota* (F. Sm.) must be regarded as endemic Four other species are recorded from W.A. for the first time.

MUTILLIDAE.

Ephutomorpha rugicollis (Westw.).—Northampton, Eradu. Previously recorded from Victoria, N.S. Wales, and Queensland.

,, *carbonaria* (F. Sm.).—Guildford. Recorded from Tasmania.

THYNNIDAE.

Enteles wagneri, n. sp.—Leederville.

,, *sanguineiventris*, n. sp.—Geraldton.

SCOLIIDAE.

Dimorphoptera unicolor (F. Sm.). -Boorabbin. Recorded also from the Swan River district.

Scolia (*Triselis*) *australensis* (Sauss and Sich.). -N. of Subiaco. Formerly known from " Nova Hollandia."

† ,, (*Triselis*) *ferruginea* (Fabr.). –Murchison District (?). In the collection of the W.A. Museum. From the northern parts of Australia.

‡POMPILIDAE.

Pseudagenia parcesignata, n. sp.—Dirk Hartog, Brown Station.

Cryptochilus (*Prionocnemis*) *tubercluatus* (F. Sm.).—Fremantle. In the collection of the Nat. Hist. Mus. of Hamburg. From the Houtman's Abrolhos.

,, *malecollocandus*, n. sp. Dirk Hartog, Brown Station.

LARRIDAE.

Larra (*Notogonia*) *chrysonota* (F. Sm.).—Coolgardie. Known also from Champion Bay.

Lyroda michaelseni, n. sp.—Denham.

MISCOPHIDAE.

Nitela australiensis, n. sp.—Denham.

BETHYLIDAE.

A single male from Guildford of an undescribed genus and species. In an appendix to the Fossores, the author notes two more species of Braconidae, *Perilitus*, n. sp., and *Lysiphlebus*, n. sp., both from East Fremantle.

FOOTNOTES by the Editors of the " Journal of the Natural History and Science Society of Western Australia."

* This species is in no way connected with *Enteles*, in which the males always have the apical spine strongly recurved as in *Rhagigaster* (Schulz). Type is a " male " specimen, but he does not give any notice of an apical spine on the hypopygium, either in the text or figure; but this spine is very liable to be broken off in many species. There is little doubt that this is

the species described as *Thynnus crudelis* by Turner in Proc. Linn. Soc., N.S.W., xxxiii, pp. 83, 238 (1908), male. Should this prove to be the case, it is placed in the genus *Zaspilothynnus*. See Proc. Zool. Soc. Lon., June, 1910, pp. 253, 356, where the female is described. Also a great number of new species, and hitherto unknown sexes.

† This is not a true *Trielis*, there being an extra discoidal cell, as in *Liacos*, but there are two recurrent nervures; the difference in neuration between this species and the other Australian *Trielis* consisting in the presence of a transverse nervure connecting the two recurrent nervures and thus forming an extra cell. Now placed in the genus *Campsomeris*. See " A Revision of the Australian Species of the Genus *Scolia*," by Rowland E. Turner, F.Z.S., F.E.S., Ann. and Mag. Nat. His., Ser. 8, Vol. IV, pp. 173, September, 1909.

‡ It is unfortunate that the old name for this family, "Pompilidae," has to be superseded (after being so long in use) by that of " Ceropalidae."

A. GIBB MAITLAND.
F. TRATMAN.
H M. GILES.

Notes on Western Australian Eucalypts, including description of New Species.

BY J. H. MAIDEN,

Government Botanist of New South Wales and Honorary Member.

(Read December 13th, 1910.)

These notes are based on field observations made by me in Western Australia from September to December, 1909, but I have taken the opportunity of incorporating a few notes from other sources.

1.—E. marginata (Sm.). "Jarrah."

Mr. William Dunn, a native of Albany, over 60 years of age, says that Mahogany is the name given by the old settlers to the timber later on known as Jarrah; that he does not remember the name Jarrah ever having been employed until the introduction of saw-milling machinery; he has sawn the timber from boyhood.

In bark and somewhat in general appearance, the Jarrah resembles the *E. resinifera* of coastal New South Wales and Queensland. It flowers as a shrub.

Following is a description of the juvenile leaves. They were received from Mr. Max Koch, and have not been previously described.

Lanceolate, sharply acuminate, slightly oblique, rounded at the base, petiolate; thin in texture, pale on the underside, glabrous on both sides; margin thickened and slightly recurved, the intramarginal vein distinctly removed from the edge; midrib distinct, lateral veins fairly distinct, pinnate, at an approximate angle of 45 degrees with the midrib, smaller veins anastomosing and obvious; oil-dots not obvious.

The irregularly striate appearance sometimes seen in fruits of this species and in a few others, e.g., *E. diversicolor* is the result of the contraction of sub-succulent vascular tissue over longitudinal bands of fibro-vascular tissue.

2.—E. buprestium, F. v. M.

Juvenile leaves (not previously described.) Ovoid to oblong mucronate, petiolate, say 2-3 inches long by 1-1¼ broad, glaucous, equally green on both sides, margin slightly thickened. Venation distinct, intramarginal vein at a considerable distance from the edge, sub-pinnately veined, with the lateral veins approximately forming an angle of 45° with the midrib.

The anthers are not typically renantherous; they are a little top-heavy, if I may use such a homely expression; they seem to form a connecting link between the typical Renantheræ and anthers such as those of *E. decipiens*, Endl., of the Porantheræ.

Very young fruits simulate those of *E. trachyphloia* in shape and size. They are slightly urceolate and have a distinct rim.

As growth proceeds, they are borne in the greatest profusion, being as close as they can pack on the previous season's wood.* Individual fruits are even larger than depicted in the *Eucalyptographia*. Mueller depicts them 1⅛ inch in diameter;. I measured them when green 1½ inches full in diameter.†

I found this species abundantly between the Kalgan River and Stirling Range. It is a tall shrub, sometimes up to 15 or 20 feet, with a Mallee habit; smooth stems. Often old large fruits and small fruits are found in the same cluster.

Dr. Diels (Engler's *Bot. Jahrb.* xxxv, 437) doubts the correctness of Mueller's locality, "near Arrowsmith River," for this species. If specimens are not in existence it should certainly be considered doubtful. I have an intermediate locality, viz., Geographe Bay (Mrs. Irvine) backed by fruits given me by the late Mr. J. G. Luehmann, of the National Herbarium, Melbourne.

3 -**E. diversifolia** (Bonpl.). **E. santalifolia** (F. v. M.). **E. pachyloma** (Benth.).

In Part vii of my "Critical Revision of the genus Eucalyptus" I have dealt with these three species. As the result of a visit to the locality of the type of *E. pachyloma*, Benth., I am able to speak more definitely as to its affinities with the other two species.

E. diversifolia, Bonpl., is not recognised by Mueller in the "Eucalyptographia" or "Second Census," being placed as a synonym of *E. santalifolia*, F. v. M. *E. pachyloma*, Benth., is also given as a synonym of *E. santalifolia*.

The following extraordinary reason for rejecting Bonpland's name is given in the following paragraph:—

> "The name of *E. diversifolia*, given by Bonpland, had to be discarded, although he described the species already in 1813, and had it illustrated by Bessa simultaneously, because the plant as defined by him represents that very young state in which, as in most species of Eucalyptus, the leaves pass from the broad form of juvenile plants into the narrow shape of the leaves, normal for adult trees. The illustration indicates well that the leaves of the young seedlings are opposite sessile and oval, a sort of characteristic, which is particularly applicable for the discrimination of specific forms also in this genus."—"Eucalyptographia," under *E. santalifolia*.

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* The figure in "Eucalyptographia" is true as far as it goes, but it is of a branch in which the fruits have largely fallen off in transit to the herbarium.

† Along with the full grown fruits are usually a few hypertrophied fruits; these display considerable resemblance to those of *E. Todtiana* or even *E. marginata*.

Bonpland's figure is an admirable one, and it includes the broad juvenile foliage. See fig. 5, plate 36, part vii, of my "Critical Revision of the genus Eucalyptus," which, of course, only reproduces a fragment.

E. diversifolia, Bonpl., has broad juvenile foliage. *E. santalifolia*, F. v. M., has broad juvenile foliage, and also narrower juvenile foliage is found in this species, connecting with *E. pachyloma*, Benth., which has narrow juvenile foliage.

We have analogous circumstances in the case of *E. Luehmanniana*, F. v. M., and *E. virgata*, Sieb. (see my "Crit. Rev. genus Eucalyptus," part ix, p. 273, footnote), and I believe that with all the many pairs of closely related species in this genus, which can only be divided by the width of their juvenile foliage, we have connecting forms in the width of such foliage.

There are other differences between the three species referred to in part vii of "Crit. Rev."

The anthers of *E. diversifolia*, *santifolia* and *pachyloma* are precisely similar, and I have a reference to the anthers of the first species at p. v of the index of vol. 1 of "Crit. Rev."

E. pachyloma, Benth., occurs north of the Kalgan River to Stirling Range, Western Australia. It is usually a spindly sandplain Gum. Bud conical, much like that of *rudis*. Juvenile leaves narrow-lanceolate.

It is quite impossible to keep *E. pachyloma* as a synonym of *E. diversifolia*. *E. santalifolia* is, I repeat, a link between the two species, and inasmuch as pictorial illustration is required for clearness, I will defer my further remarks until I deal with *E. pachyloma* in a subsequent part of my "Critical Revision."

4. **E. calycogona** (Turcz.) Typical form.

In addition to the Western Australian localities recorded in "Critical Revision," part iii, p. 83, I collected it at Desmond, near Ravensthorpe, where it is a tall shrub.

Mr. Max Koch (No 1,169) sent it to me from Cowcowing, a small tree of about 30 feet, with a smooth grey bark.

Var. **gracilis** (Maiden).

See part iii, p. 81, of my "Critical Revision."

The juvenile leaves (I am describing specimens from Southern Cross, W.A.—J. H. M.) are glaucous on both sides, acuminate, tapering to a rather long petiole, lanceolate, the lamina say 3 inches long by $\frac{3}{4}$ in. broad, the intramarginal vein at a very considerable distance from the edge, venation spreading, the midrib and intramarginal vein being most conspicuous, giving the leaf a triplinerved appearance.

So far as I am aware, the juvenile foliage of var. *gracilis* has not been previously described. Some from Euston to Mildura, Victoria (W. S. Brownscombe) (not far from the type locality) are smaller, and from nearly elliptical to oblong in shape. They do not taper to a point, but are of the same general character as those already described. Then I have juvenile foliage from South Australian localities, collected by myself, which is narrower in width, but as it is not in as early juvenile stage as that described by me from Western Australia, I invite attention to the matter in order that representative specimens may be collected.

On the Kurrawang wood line, at a distance of nearly 70 miles north of Kurrawang, I found a large tree known as "Snap and Rattle Gum" in abundance, which, in my opinion, belongs to this species. The type form is, of course, a shrub, but the Kurrawang form (and it is common in the drier parts of Western Australia) is over 2 feet in diameter, but not tall, and grows in divaricate clumps, but not mallee like.

It has flaky (thin box-like) bark at butt, smooth above, and like so many of the Goldfields Eucalypts, a deep cigar-brown timber. In the Kurrawang district it is always a rotten tree, not of much account as a fuel wood, being full of pipe and dirt. It gives great heat and hence good for loco. fuel, but it is too dwarf and crooked for the mines.

The variety is rather common at Southern Cross. It also occurs at Kalgoorlie. Mr. O. H. Sargent also sends it to me from near Salt River, 10 miles east of County Peak, Beverley, as the "Parker Gum" of the *new* settlers, but not to be confused with the true "Parker Gum" allied to or identical with the "Morrel," see p. 171

Specimens of var. *gracilis* have angled fruits connecting with those of *typica*, e.g., Euston to Mildura, Victoria (W. S. Brownscombe).

I will point out under var *celastroides* that the varieties *gracilis* and *celastroides* run into each other. This applies to the fruits; it also applies to the leaves, which are sometimes of the intermediate character, neither glaucous (as var. *celastroides*) nor shiny (as var. *gracilis*).

Var. **celastroides** (Maiden).

See my "Critical Revision," part iii, p. 79.

Following are field notes of three trees from localities at a considerable distance from each other:—

(1) Two feet in diameter, box-like bark, smooth branches, fruit rather small (as small as var. *gracilis* often is). Foliage somewhat pendulous. Kalgoorlie.

(2) "White Gum" or "Blackbutt." Suckers glaucous (stems square), medium-broadish. Timber cigar brown, a litttle bark (rough) at butt, smooth above. Fruit urceolate, somewhat like var. *gracilis*, but quite different from "Snap and Rattle." Lannin's timber camp, about 70 miles north of Kurrawang.

(3) "Blackbutt," 18 inches in diameter, 30 feet high, more or less pendulous. Branchlets glaucous. Did not find suckers. Rough bark extending more up trunk than *E. gonianthа* var.

Clelandi, which is more fibrous flaky than the present form. Goongarrie, 54 miles north of Kalgoorlie.

Var. *celastroides* may be briefly described by foresters as a coarse form of var. *gracilis*.

The differences appear to be as follows. Both are trees (in Western Australia) of medium size, with brown timber.

	Var. gracilis.	Var. celastroides.
Juvenile leaves...	Already described ...	Coarser, with often thicker leaves and venation more prominent.
Branchlets	Slender, round, scarcely angular	Commonly angular, often quadrangular.
Mature leaves	Shiny	Dull or glaucous.
Flowers	Anthers of *typica*, of var. *gracilis* and var. *celastroides* alike	
Fruits	....	Larger, sometimes much larger, sometimes more urceolate.

I have considered the question of keeping var. *gracilis* and var. *celastroides* apart as species, but although extreme forms would appear to justify this step, I have some forms which can only be separated from one variety or the other with the greatest difficulty, if at all. Nor could I, in the field, say that the two forms were sufficiently distinct as to be accounted different species.

5.—E. uncinata (Turcz.).

I only came across (with certainty) this species in two districts in neither of which did it appear to be very plentiful. I have other incomplete material, concerning which I reserve judgment.

(*a*) Kalgan Plains, with narrow leaves and the juvenile leaves glaucous. A round-headed many-stemmed shrub of a few feet, with red buds. Sometimes a spindly, rather erect shrub.

This species infrequently affords an example of the not very frequent instances in which the broad juvenile leaves remain persistent, as regards shape, unto maturity, *i.e.*, until the inflorescence of the plant.

(*b*) Hopetoun. Here the shrubs are larger and coarser. with the operculum acuminate, bent, and longer than the calyx. Probably the var. (?) *rostrata* of Bentham.

6.—**E. oleosa** (F. v. M.).

The species was originally described from South Australia, and I did not see much of the typical form in Western Australia.

A small tree at Pindar (Murchison line) is nearly typical, It has a rough dark flaky bark and smooth limbs. The timber is dark (cigar) brown, but the tree is quite pipy, the timber is, however, darker than *oleosa* usually is, which is reddish brown, but that may be owing to the age of the tree. Only young buds and ripe fruit found, and very few trees were seen.

Some small trees at Ravensthorpe, west of Esperance, have small fruits and are not very dissimilar to specimens of *E. oleosa* collected from localities of the type, but the juvenile foliage is remarkably narrow. This will be figured in part xv of my "Critical Revision," and is so narrow that it excites suspicion that we have here a different species, but the other characters are those of true *E. oleosa*, and we have already many instances of considerable variation in regard to juvenile foliage. The Ravensthorpe trees should be watched, as the specimens taken by me may prove to be extremes.

At Comet Vale (via Kalgoorlie) I noticed a small erect, rigid gum, leaves very thick, fruits a little more pear-shaped than usual. In bud and ripe fruit. It is a coarse form of *E. oleosa*, and I did not find this particular form anywhere else.

Var. **longicornis** (F. v. M.). "A Morrel."

This form was described by Mueller in *Fragm.* xi, 14, and raised by him (with doubt) to the rank of a species under the name of *E. longicornis* in his "Report on the Forest Resources of Western Australia," p. 12, and fig. 13.

He says "It agrees with the York Eucalypt (*E. loxopheba* or *fœcunda*) in its bark." At p. 7 of the same work he describes the bark of the York Eucalypt as "persistent and rough." Of course, the latter is a well-known species.

It is a glabrous form, and, in my view, it is identical with a tree called "Poot."

My attention was first directed to "Poot" by Mr. Andrew Murphy, of Sydney, whose collector (Mr. Louis Dillon) sent him some seed from Broome Hill. This was in 1905, and I have never lost sight of the matter since. It was described as a tree 3 feet in diameter, the timber used for wheelwrights' work, and it does not split well. In my recent trip I visited Broome Hill specially to see this tree. Following are some notes on this tree made by me on the spot:

Grows on good land; on the best land. A large tree. Dark grey, narrow furrowed or hard " box " bark, covering the whole of the trunk up to the first fork and the larger branches. It looks like a black-barked tree.

The smaller branches slightly ribbony and smooth. It is erect and attains a large size, up to 6 feet diameter. Timber reddish. Good burner.

A good many people look upon Poot as identical with Morrel. At the same time opinion is divided on this subject in Western Australia. I had not the opportunity of seeing Poot and Morrel alongside each other and of cross-examining people on the spot as to their supposed identity.

The Morrel as I saw it has a smoother and more flaky bark, and is less erect in habit than Poot. It is a glaucous Goldfields tree mainly, and I believe both var. *longicornis* and var. *glauca* run into each other, and both to some extent bear the same name (" Morrel ").

Mr. William Dunn, of the Porongorups, informs me that Poot occurs north of Stirling Range, on the Salt River, and extensively in the direction of York. That it is a very hard timber, harder even than Yate, which is usually quoted as the standard of great hardness.

Mr. Van Zoolikum, of Katanning, informed me that " Parker Gum " found in the York district, is identical with Poot, and that it was named after a Mr. Parker, forbear of some respected legal gentlemen in Perth. I have not seen indubitable specimens of " Parker Gum," but would like to do so.

Mr. H. F. Johnston, Surveyor-General, Perth, is one of those who are of opinion that Poot " is a Morrel."

Mr. Johnston states there are two Morrels, the ordinary one and a second, with no trace of red in the timber, but with timber somewhat like York Gum, which he calls Yorrel. Probably we have an instance of hybridism here, but I have not seen the specimens.

I have opened out a very interesting subject, and should very much like to obtain small axe-cuts, showing bark and wood and also twigs showing buds, flowers and fruits, and also juvenile leaves, of each of the trees referred to, in order that the various points raised may be cleared up.

Var. *glauca*, var. nov.

" Morrel " (the glaucous or Goldfields form); called also " Blackbutt " on the eastern goldfields.

Seventy miles north of Kalgoorlie I took notes on the spot of a tree as follows:—

A medium-sized tree, say 1 foot in diameter, a White Gum with blotched bark and more or less short flaky ribbons on the trunk, with a little of the roughness at the butt.

Colour of timber rich reddish brown and very tough. A felled Morrel shows long tough splinters.

Tips of valves connected as in *E. oleosa.*

It is usually glaucous (typical var. *longicornis* is always glabrous). The buds and fruits are coarser than those of var. *longicornis*, the operculum is more or less rostrate (particularly in dried specimens), *i.e.*, it does not taper gradually as in the case of var. *longicornis.* While all the forms of *E. oleosa* run into each other, I am of opinion that the arboreal glaucous goldfields form merits a varietal name as much as var. *longicornis* does, and therefore I have proposed the name var. *glauca* for it. Figures are desirable to show the relations of the various forms, and I have arranged for these in a forthcoming part of my "Critical Revision."

Var. *Flocktoni*, var. nov.

An erect many-stemmed shrub of 6-8 feet. Branchlets somewhat angular. Juvenile leaves unknown.

Mature leaves coriaceous, thick, equally green on both sides, dull to slightly glossy, petiolate, lanceolate to broadly lanceolate (common dimensions are, petiole 1-2 cm., leaf 10 cm., breadth 2-3 cm.).

Flowers pendulous, up to 7 in the umbel, with a common peduncle of 1 cm. and pedicels of half that length, calyx subcylindrical (about 4 cm. long), operculum tapering, constricted when dry, of slightly greater diameter than the calyx at the line of junction (about 6 cm. long). Anthers similar generally to those of the *oleosa* group, but less broad at the base than that of typical *oleosa.* Pistil long, as long or longer than the stamens, stigma not dilated.

Fruits urceolate, furrowed longitudinally but irregularly, much constricted at the orifice and tapering gradually to a rather short pedicel, of greatest diameter midway between the orifice and the pedicel, 1 cm. in length with a diameter of .75 cm., the valves well sunk within the capsule or the ends of the slender tips of the same nearly approaching the orifice, rim narrow and furrowed.

Its closest affinity appears to be to *E. oleosa*, F. v. M., and to the var. *glauca* described in this paper, but the fruit renders it sufficiently different from any other form of *E. oleosa.*

Esperance, Lindley L. Cowen, January, 1902. Desmond, near Ravensthorpe, J. H. Maiden, November, 1909, apparently not abundant.

In honour of Miss Margaret Flockton, the accomplished artist of my "Critical Revision of the genus Eucalyptus" and "Forest Flora of New South Wales."

7.—E. falcata (Turcz.).

The type is Drummond's 3rd Coll. No. 70, which I received on loan from the Oxford Herbarium, and caused a careful drawing to be made of it. Bentham (*B. Fl.* iii, 248) gives the furrowing of the calyx-tube as a character, and quotes Maxwell's specimens, "plains north and south of the Stirling Range."

The operculum is in the typical form much narrower in diameter at the junction with the calyx-tube. The fruits also are furrowed (or ribbed).

As definite localities are few, I give the following: —

Yetmerup, north side of Stirling Range (A. Morrison); Toll's Creek, Stirling Range (A. Morrison); Stirling Range (Diels 2989, distributed as *E. decurva*); Stirling Range (Louis Dillon); Hopetoun (J. H. M.), with normal and also very large fruits.

Var. *ecostata*, var. nov.

The calyx-tube of this species is often free or nearly so from furrowing (or ribbing), and the same applies to the fruits. I propose to constitute a variety for this form, and give it the name *ecostata*.

In the variety there is often not an abrupt transition between the calyx-tube and the operculum as in the normal form.

The variety is not a strong one, since there is frequent and absolute transition between it and the species. It seems, however, desirable that the form should have a name, particularly as fruits of this species, and perhaps of the variety have entered into the confusion which for so long gathered around *E. decurva*, F. v. M., and which I have now cleared up.

8.—E. decurva (F. v. M.).

Maxwell's locality for the type is Porongorups and I have re-discovered the species (as indeed had Diels). Figures are desirable to clear up certain confusion that has gathered around it. Accordingly *E. falcata*, Turcz., and *E. decurva*, F. v. M., will be dealt with in parts xv and xvi respectively of my "Critical Revision."

9.—E. incrassata (Labill.).

I collected specimens very close to those of the type (normal form) at Hopetoun and at Esperance.

Var. *angulosa*.

This is by far the most abundant form of *incrassata* in the south coastal districts visited by me. In sheltered places near the sea it forms large shrubs or small trees, shapely, with dense foliage forming an agreeable shade, and a graceful ornament to the beach. It is common between Albany and Esperance. I have since received it from Point Malcolm and Middle Island (Cape Arid) from Mr. G. Simmonds.

On the Kalgan Plains also it is the tallest of the mallees (say 15 feet) with fleshy, large leaves. In such situations, which are more exposed, it has smooth, clean stems (say 3 inches) with the leafy branches coming less close to the ground.

Var. *dumosa*, F. v. M.

I collected it rarely on the Kalgan Plains, also at 9-mile Tank, near Hopetoun, and Desmond, near Ravensthorpe.

At Dongara, not far from the beach, is a dense growth of slender White Gums, ribbony at butt, which reminds one of dense Mallee, but not true Mallee, 20-25 feet high, trunk 4 inches diameter. Wood very tough, a little brown at heart. Operculum a little ribbed. Broad coarse suckers. It is very close to typical *incrassata*, certainly a connecting link.

Var. *conglobata*.

This variety occurs not unplentifully at Kalgan Plains, Hopetoun and Esperance. Specimens from the two latter places have the fruits unusually large and with the rim well defined.

10.—E. striaticalyx (W. V. F.).

This *Journ.* i, 20 (May, 1904).

I found this species at Milly's Soak, near Cue, one of the type localities, and following are the notes taken by me on the spot.

E. striaticalyx is far less numerous than *E. microtheca*, and is on the edge of the *microtheca* belt. Called "York Gum" by local people, but they are free and easy with their names for trees. It was plentiful on a donga. Stumps are now seen 12-18 inches in diameter between Milly's Soak and Jack's Well, and it was formerly extensively cut for firewood, but the neighbourhood of Milly was made a recreation reserve and the remaining trees were saved.

Tree of 30-40 feet. Bark dark grey or blackish, flaky, thin, yellow inside covering the whole of the trunk and part of the branches.

Timber very hard, pinky pale brown or pale brown when fresh. Rather erect in habit. Would be called a Black Box in Eastern Australia. Neither Mr. Fitzgerald nor I found flowers, but I collected timber and juvenile leaves, which he did not.

In my opinion this is a variety of *E. incrassata*. The juvenile leaves are as nearly as possible the same as those of var. *dumosa* collected by me at Dongarra. The Dongarra trees are large, so are those of the same species at Kangaroo Island, South Australia The Milly's Soak trees are exceptionally large for *E incrassata*, so are those of the two localities I have quoted. The timbers of the two species appear to be similar.

The fruits are those of *E. incrassata*, while the ribs of the opercula are characteristic of those of *E. incrassata*.

I shall be glad if any correspondent can favour me with flowers, but at present I see no grounds for separating it from the protean and widely diffused *E. incrassata*, Labill.

11.—E. torquata (Luehmann).

The author gives the type locality "in the neighbourhood of Coolgardie" when referring to it in my "Critical Revision," part iv, p. 109, although I had received it from Mr. (now Dr.) Webster, I still only had the bare locality "Coolgardie district."

It does not occur close to the township of Coolgardie and it seems desirable to give the following more specific localities: Widgiemooltha (Diels and Pritzel), Norseman (W. D. Campbell), through Dr. A. Morrison).

12.—E. Stricklandi, sp. nov.

Probably a shrub, but no particulars furnished. Branchlets glaucous. Juvenile leaves not seen.

Mature leaves pale dull green on both sides, afterwards glossy on both sides, coriaceous, thick, petiolate, lanceolate (the few leaves seen up to 10 cm. long and 2-3 cm. broad).

Flowers.—The buds three to six in the umbel as seen, sessile on a very broad flat peduncle 1-1.5 cm. long. Opercula nearly ovoid, the calyx-tube markedly expanded at the line of junction forming a well-defined ridge, and forming an "egg-in-egg-cup" arrangement. Calyx-tube of about the same length as the operculum (1 cm.) ridged and flattened so that two of the ridges almost form wings.

Long narrow anther, with long narrow gland, filament nearly at base; is related to *E. incrassata* as regards anthers. Filaments dry red.

Fruits.—Sub-cylindrical, very slightly urceolate, two equidistant sharp low ridges or wings, sessile, about 1.5 cm. long by 1 cm. in diameter ,rim grooved and narrow, valves (4 in the specimens seen), with their tips below the orifice.

The closest affinity of this species is to *E. grossa*, F. v. M., from which it differs in the peculiar shape of the buds, and to a less extent in the fruits. The filaments of the new species dry red, while they appear to always remain yellow in *E. grossa*.

I cannot see my way to assume that it is a variety of that species.

It is a remarkable plant, is probably small and is worthy of cultivation for its handsome and striking flowers. It is named in honour of His Excellency Sir Gerald Strickland, K.C.M.G., Governor of Western Australia.

13.—E. corrugata (Luehmann).

I collected this rare species about five miles from Southern Cross, going northerly. A tree of medium size, glaucous at the time of my visit (September).

14.—E. goniantha (Turcz.).

The juvenile foliage is hitherto unknown. I am describing Kalgoorlie specimens and the branchlets are angular, and they and the juvenile leaves are glaucous. Leaves ovate-lanceolate to ovate, coarse, thick, say 10 cm. long by 7 cm. broad in some specimens, petiolate, thick, venation distinct, rather more prominent on the underside, venation spreading, becoming more pinnate as growth proceeds, margin of leaf thickened and intramarginal leaf distinctly removed from the edge, oil dots obvious in the early stage.

The localities given for this rare species in the *Flora Australiensis* are "King George's Sound or to the Eastward" and "Franklin River," all coastal localities. On my recent trip I collected it at Kalgoorlie and also on a wood line (about 70 miles north of Kurrawang, while I have received it from Dr. A. Morrison (Hampton Plains, near Coolgardie, E. Lidgey).

It may be useful to say that as compared with another "corrugated" species, *E. corrugata* ,they may be sharply separated on the anthers, *E. corrugata* belonging to the *E. incrassata* series and *E. gonantha* that of the *E. oleosa* series.

E. goniantha has broad suckers and pointed operculum, while the suckers of *E. corrugata* remain unknown and its operculum is round.

Var. *Clelandi*, var. nov.

I now describe diffidently as a variety of this species a tree which, when flowers are available, may turn out to be a new species. I name it in honour of Mr. A. F. Cleland, of Kurrawang. who gave me facilities for travel on the private line of a company with which he is connected, and where I collected this and other imperfectly known trees and of Dr. J. Burton Cleland, nephew of the above, who made many botanical investigations in Western Australia before coming to Sydney.

Following are observations made when standing before the trees, and valuable for that reason.

(1) Lannin's Timber Camp, nearly 70 miles north of Kurrawang, where it is widely diffused. A Blackbutt. Bark hard-flaky and black in colour at butt. Timber cigar-brown, very hard, but not so tough as Morrel.

(2) Goongarrie, 54 miles north of Kalgoorlie. A "Blackbutt," 18 inches in diameter and 30 feet high, with bark fibrous-flaky at butt, the rest and all the branches smooth Branchlets glaucous, as likewise the whole of the saplings.

Foliage more or less pendulous.

Juvenile leaves ovate-acuminate, pedunculate, equally glaucous green on both sides, venation not conspicuous, except the midrib, intramarginal vein distinctly removed from the edge.

Mature leaves narrow-lanceolate, 12 x 1.5 cm., being common dimensions, petiolate, dull green, coriaceous, venation not conspicuous, lateral veins feather-like, intramarginal vein hardly removed from the edge.

Buds with long corrugated opercula, the calyx-tube but slightly corrugate or smooth. Diameter of the operculum slightly exceeding that of the calyx-tube at the line of junction.

Fruits numerous, very glaucous, nearly sessile, on a common peduncle of about 1 cm. Subcylindrical in shape, about 5 cm. long, valves slightly exsert.

15.—E. Griffithsii, sp. nov.

A large White Gum, attaining a trunk diameter of two feet, timber reddish-brown in colour and esteemed for fuel.

Juvenile foliage thick, narrow-lanceolate, petiolate, but not seen in the strictly opposite stage. Dull green, the same colour on both sides, oil dots fine and numerous, intramarginal vein not obvious and not far removed from the thickened margin. Venation, except the midrib, obscure.

Mature foliage, thick, narrow lanceolate or lanceolate; 10 cm. long, 2 cm. broad, with a petiole of 2 cm. are common dimensions; glabrous or glaucous, equally green on both sides, intramarginal vein near edge, or forming the thickened margin, midrib distinct, lateral veins feather like.

Buds.—Flat-topped, corrugated, with two of the ribs broadened almost into wings, so as to give the buds the appearance of having broad pedicels. The common peduncles rounded or only slightly flattened. In threes.

Flowers.—Stamens white, but bases of filaments pinkish. Anthers very large and long, with an oval-shaped gland at the back.

Fruits.—Large, conoid, capsule white, valves distinctly exsert, rim flat. Corrugated, two of the ridges usually dilated almost to wings. Immature fruits with these wings forming flattened pedicels and giving the fruits an almost sessile appearance. As maturity approaches the fruits become more hemispherical at the base and the nearly round, comparatively slender pedicels become accentuated from the fruits. The common peduncle often 2 cm. long and nearly round.

"White Gum" magnus foliis juvenibis angustis, glauco-viridibus concoloribus, venis obscuris praeter costam mediam. Follis maturis confertis angusto lanceolatis vel lanceolatis, 10 cm longis, 2 cm latis, petiolo 2 3 cm. longo eodem colore utraque pagina, margine calloso, venis lateralibus plumosis.

Gemmis apicibis planis costatis duabus costis fere in alis dilatatis, floribus ternis, antheris magnis longisque, a tergo glandula ovale. Fructibus magnis conoidis, valvulis aperte exsertis, margine plana."

The type comes from Kalgoorlie, where, as a large tree, it is now very scarce, because of the great demand for timber of every kind for the mines and for ordinary domestic purposes all over the Eastern Goldfields.

This handsome species is named in honour of my friend John Moore Griffiths, of Melbourne, who has taken an active interest in my work for nearly thirty years.

E. Griffithsii is referred to in part iv of my "Critical Revision" as a form of *E. incrassata*, with blunt opercula and large subconical fruits. Figured at 5a to 5d of plate 15 of that part.

It belongs to the *E. incrassata* series as regards anthers, and that affinity is borne out by examination of other morphological characters. It is, however, sharply separated from that species by the narrow juvenile foliage.

Its closest affinity appears to be *E. corrugata*, Luehmann, from which it is sufficiently separated by the more numerous and more accentuated corrugations of the buds and fruits and the smaller fruits of *E. corrugata.*

16.—E. leptopoda (Benth.).

A thin, wiry, rather erect tall shrub or small spindly tree, with several stems together. Juvenile foliage narrow-lanceolate, thick, equally green on both sides, no vein obvious other than the midrib.

No locality was given in the *Flora Australiensis* for this species. Diels gives "25 Km. south of Menzies," which is probably near Comet Vale, where I found it in abundance.

I received it from Dr. L. G. Webster from Coolgardie, from Dr. A Morrison from Boorabbin, from F. H. Vachell from Kellerberrin, and collected it at Tammin, which is the furthest west recorded on the Perth-Kalgoorlie line. I have received it from Mr. Max Koch, from Watheroo (rabbit fence), so we see that its range is fairly extensive. We want a good deal of collecting yet to settle the range of Western Australian species.

17.—E. salubris (F. v. M.). "Gimlet."

Grows on flats and not on ridges. Has a peculiar olive green hard bark (reminding one of *E. stellulata* of the east a little). The whole stem often twisted like a gigantic corkscrew, less like a gimlet.

Gimlet saplings are thin and graceful

Many Gimlet trees have short uniform ribbons all up the trunk; they stick out and such gimlets are termed "feathery." I particularly noticed this on the Kurrawang wood-line.

Juvenile leaves lanceolate and glaucous.

18.—E Preissiana (Schauer).

As I emerged (5 miles) from forest on to plain land on the Takalarup Road, coming from the eastern end of the Porongorups, I saw the first patch of this species; but not till I reached 6½ miles did I see it in abundance. I found it again 2 miles from the Stirling Range, on the Kalgan Plains.

It forms spindly shrubs up to 10 feet, most of them smaller.

Ripe fruits were very plentiful, also buds bearing double opercula, but flowers were scarce and I could not find a plump bud (November). I found a few opercula on the ground. They are rather flat.

The young leaves are decussate or nearly so.

19.—E. gomphocephala, DC.

Tuart reminds one of the "Box" trees (*hemiphloia*) of Eastern Australia, except that the branches are not smooth and therefore have no ribbons. The resemblance is closer to *E. Stuartiana*, "Apple tree" of Eastern Australia.

The wood is pale coloured with a yellowish cast. I found it cut extensively at Ludlow and other places in the Busselton district. It is confined to the limestone strip.

20.—E. megacarpa (F. v. M.).

A medium sized tree known as "Blue Gum."

Bark like a White Gum or perhaps like a Grey Gum (*E. punctata* of eastern New South Wales) to some extent. Bark rather thick. Wood not hard, with large gum veins (brown kino) and brownish towards the heart. A gouty useless timber tree.

Mr. Percy Murphy, who visited Western Australia a few months before me, called it "Flooded Gum." He got it at Karridale, near Cape Leeuwin, and describes it as 2 ft. 6 in. in diameter, a stunted tree not used locally; grows on top of hills. Close to sea.

The trees I found between Princess Royal Harbour and the granite rocks on the ocean side known locally as "The Caves," were growing in damp, low-lying sandy land.

21.—E. Oldfieldii (F. v. M.).

Mueller's "Eucalyptographia" includes under this species *E. Drummondii*, Benth. (*B. Fl.* iii, 237) as being a form smaller in all its parts.

I collected *E. Oldfieldii* at Minginew, where Dr. Diels collected it.

It has an ovoid operculum, more or less rostrate. Its juvenile foliage is petiolate and ovate, not broad, with the intramarginal vein distinctly removed from the edge.

It is a stiff bush of 8 or 10 feet, with many thin stems close together, forming an impenetrable scrub, but not a true Mallee. It is not a timber tree.

Mr. Max Koch (his 1256) sent it to me from Cowcowing, "a small tree or shrub with a ragged bark."

Var. *Drummondii* (?).

An interesting form I refer to this species was collected by me at 66¼ mile-post, Pindar, Murchison line.

Many-stemmed, 10-15 or 20 feet. Tough wood. Peculiar bark, falling off in narrow longitudinal pieces, giving it a striped appearance. The indurated stems are 3 inches in diameter. Several clumps seen.

Very yellow buds with hemispherical and absolutely no mucro. Operculum, which is distinctly smaller than the calyx, affording one the best example I remember of the "egg-in-egg-cup" bud. It is certainly not typical for var. *Drummondii*, and I regret I have not complete material.

I also refer to this variety a tree of 20 feet, trunk and branches smooth, whitish buff, with a few semi-detached scales of dead bark. Cut Hill, York, O. H. Sargent, No. 266.

A form collected by Dr. A. Morrison, at Mt. Saddleback, Marradong, Williams district, is remarkable for its conical operculum.

An anomalous form is one (fruit and leaves only) whose large fruit cannot be described as having a depressed capsule. It was collected by Dr. J. B. Cleland, who describes it as a "very clean White Gum, foot of Darling Range." It is obviously a large-fruited form of Sargent's No. 266.

Western Australians should examine *E. Oldfieldii* and its forms in the bush, and should particularly collect juvenile foliage while still in the opposite stage. Examination of these will probably settle the matter of the relation of *E. Oldfieldii* to its varieties and whether we have a second species.

22.—E diversicolor (F. v. M.).

The Karri corresponds to the Blue Gum (*E. saligna*) of Eastern Australia.

It covers the tops and sides of the Porongorups and also occurs in ferny and rather low-lying ground generally in the South-West.

23.—E. Guilfoylei, n. sp.

In honour of William Robert Guilfoyle, late Director of the Botanic Gardens, Melbourne, who, when in office, actively promoted the cultivation of the especially beautiful flora of Western Australia.

A tall tree with fibrous or stringy bark to within a few feet of the branches; timber pale-coloured and fissile·

Locally called "Tingle Tingle." It occurs on the edges of Karri (*E. diversicolor*) forests, between the Denmark River and the Leeuwin, in deep gullies. The local timber-getters look upon it as a hybrid ("bastard" in ordinary Australian timber parlance).

Type.—Denmark, Western Australia. A Murphy, March, 1905.

Seedlings. –Hypocotyl tapering very gradually into the root, crimson, like the petioles of the cotyledonary leaves, and of the young axis and petioles, the cotyledonary leaves nearly reniform in shape and crimson underneath. The young leaves petiolate from their earliest stages, elliptical, tapering slightly into the petiole and into a terminal point, venation looped.

Juvenile leaves.—Thin, glabrous, paler on the lower side, petiolate, ovate-acuminate, about twice as long as broad (say four by two inches), midrib prominent, distinctly raised on the lower surface and exhibiting a slight channelling on the upper; lateral veins nearly parallel, making an angle of about 130° with the midrib, very fine, intramarginal vein not conspicuous and not far removed from the leaf-margin.

Mature leaves.—Coriaceous, equally green on both sides, drying pale, nearly symmetrical, broadly lanceolate, up to 6 inches long and more commonly a quarter of that wide in the widest part, with a distinct midrib and abundant fine lateral parallel veins, making about an angle of 30° with the midrib, scarcely visible in mature leaves, circumferential vein marginal or very close to it, oil-dots fine, the leaves not rich in oil.

Buds and flowers.—A profuse flowerer. Expanded flowers not seen and only three-quarter grown buds.* Inflorescence a compound panicle, peduncles very angular. Buds in umbels up to 7 in the head on a long flat peduncle, the buds nearly sessile, the angular calyces tapering into the very short pedicels. Operculum nearly hemispherical and less than half the length of the calyx.

Fruits.—Truncate pear-shaped, with a marked angle and frequently a second one diametrically opposite to it. Barely 1 cm. long and slightly less in greatest diameter. Rim sunk, three to four valved, with the points of the valves completely sunk within the orifice or approaching the same; not seen protruding.

Arbor altus, cortice fibrosa, ligno pallido et fissile.

Foliis juvenibus tenuis, glabris pallidioribus inferiore latere, petiolatis, venis, lateralibus tere parallelis et tenuisissimis.

Foliis maturis coriaceis, lato lanceolatis, venis lateralibus tenuibus

Pedunculis angularibus gemmis operculis fere hemisphericis Flores non vidi.

Fructibus truncatis similibus piro formatis, aperte angularibus, vix 1 cm longis et aliquanto minis maximo diametro. Margine depresso, apicibus valvularum omnino in orificio.

Affinities.—1. With *E. diversicolor*, F. v. M.

The affinities of the two species, as far as herbarium specimens are concerned, are very close. The bark of *E. diversicolor* is smooth and the timber red; these two characters sharply differentiate the two trees in the bush.

The seedlings of the two species are very similar.

---

* I have been trying for over four years to get ripe buds and a few flowers, but without success.

An immature anther taken out of these unripe buds shows a large gland at the back, but the pores or the slits are not developed. In approaching maturity, the comparative size of the gland diminishes. The anther seems to be nearest to that of *E. ochrophloia* (F. v. M.).

The juvenile foliage (suckers) of *E. diversicolor* appear to be more orbicular

The mature foliage of the two species is very similar.

The buds of *E. diversicolor* are less angular and the operculum is usually more conical.

The fruits of *E. diversicolor* are less pear-shaped, there being a sharp accentuation between the fruit proper and the distinct pedicel. When unripe there is a distinct rim and a tendency to be urceolate which I have not noticed in *E. Guilfoylei.*

2. With *E. patens* :—

The affinities of these two species is close, so far as herbarium specimens are concerned.

The juvenile foliage of *E. patens* has the marginal rim further removed from the edge and the lateral veins more prominent and looped. The juvenile leaves of *E. patens* are sessile and even stem clasping. Those of the Tingle Tingle have a fairly long petiole, and the lamina tapers towards the petiole

The mature foliage is not very dissimilar at first sight. The venation of *E. patens* is more spreading (?), the buds less angular, the opercula more pointed and the fruits larger, more spheroidal, not angled, and sharply accentuated from the short pedicels.

The bark of *E. patens* is softer and less fibrous, and the timber appears to be paler, softer, less fissile, and heavier.

The bark of Blackbutt (*E. patens*) may be described as follows :—

Rough bark all over stem and branches, soft, thick, greyish black, much resembling that known as Woolly-butt in the Eastern States.

E. Guilfoylei has been described as resembling the Jarrah in general appearance, but the bark of the Jarrah is less rough.

> "This tree (Tingle Tingle) is in appearance very like the White Mahogany (*E. acmenioides*, Schauer (J. H. M.) of New South Wales. The tree is sometimes about four feet in diameter, the average is two to three feet ; the height over a hundred feet. The timber is good and durable, splits well, is used for palings and fencing, is sawn up for house building purposes, and should make good railway sleepers It grows in rich red loamy soil in the Karri hills, where it is fairly plentiful, at Denmark, Western Australia. It is entirely a different tree from the Karri."—Andrew Murphy and Louis Dilion.

Mr. Andrew Murphy, of Woy Woy, New South Wales, first drew my attention to this tree in 1905, he having received seed from Western Australia I have been trying for five years to get flowers to examine the anthers, but have not succeeded yet.

When recently in Western Australia, I found the tree not in flower, and appealed to the Surveyor-General (Mr. Harry F. Johnston) for information. He gave me a copy of the following report by Mr. H. S. Brockman, Inspecting Ranger, to the Inspector-General of Forests :—

> "In reply to your letter re the Tingle Tingle forest I met with on my trip of inspection to the Frankland River.

This tree seems to be confined in its natural growth to the hills along the Frankland River, where it predominates and extends about 10 miles up.

As regards the timber it is pink in color, hard, tough, and light. For such work as general wheel manufacture, axe and other tool handles, requiring a tough light wood this timber should be most suitable.

In general appearance the trees resemble very much the Blackbutt. It reaches a height of quite 200 feet: one tree measured was 45 feet round the base, 38 feet round six feet from the ground, and about 50 feet to the first branch.

There is another tree growing in the vicinity of Denmark which is locally known by the same name and in general appearance is identical to the Frankland River timber but on examination I found the color and texture of the wood quite different, the Denmark timber being quite a yellow or "Boxwood" colour."

There is also a timber known as "Red Tingle Tingle" and the following report of Mr. Fred. S. Brockman, Chief Inspecting Surveyor to the Surveyor-General, describes it. It is probably also the tree referred to in the last paragraph of Mr. H. S. Brockman's letter just quoted :—

On the east side of the Frankland River there is a small patch of very fine Red Tingle Tingle. This is a very handsome wood, varying in colour from a dark yellow to red with faint black lines radiating from the centre of the log.

It should be eminently suitable for cabinet work Both in size and symmetry these trees are the finest in the State.

A rough measurement of one gave a girth of 39 feet at five feet from the ground. I estimated the height of the clean trunk to first branch at 50 feet. I have seen numbers of them whose bare circumference is not less than 30 feet with upwards of 100 feet of clean trunk. It grows on the steep ridges flanking the river and could, I think, be easily lightered out

The soil here, though the best on the Lower Frankland, is not of the finest quality, and is usually too steep for cultivation or grazing."

Another report by the same gentleman, referring to "Red Tingle Tingle," will be found in the *West Australian* of the 16th October, 1910 :—

"Upon crossing the Frankland I postponed the further selection of a road route towards Denmark, and turned southerly towards Nornalup. Until reaching a point about ten miles north from the inlet the country consists principally of plains similar to those between the Frankland and Deep Rivers. Between this point and the coast hills the country traversed by the Frankland is very hilly, rising only about 400 feet above the river, but broken, as it is, by innumerable deep lying streamlets it might almost be described as rugged. Along the faces of the hills sloping into the Frankland there are patches of fairly good and deep loams These are covered with red Tingle Tingle and Karri and are, therefore, unavailable for selection. This is the only country on which I have seen the Red Tingle Tingle. It is, I feel sure, a most valuable wood for ornamental purposes. All the logs I have seen felled are very round and free from gum, veins, or faults, and the tree is in appearance quite the finest eucalyptus in the State, one that I roughly measured and estimated being 45 feet in girth at the base and 39 feet at the point. Five feet above the ground from this point it rose a clean straight trunk for nearly 50 feet before branching. I saw numbers of trees of somewhat less girth dimensions that must reach an altitude of not less than 100 feet at the first branch. I had touched the edge of this timber on an earlier visit to Nornalup, and then called it in my notes "fine jarrah," to which in the bark it bears a close likeness."

The Acting Inspector-General of Forests has been kind enough to forward me fruits and intermediate leaves of the Red Tingle Tingle from which it appears that the tree does not really differ from the Tingle Tingle I have described.

Tingle Tingle timber is undoubtedly a valuable one, local in distribution; and further enquiries in regard to it are desirable. In saying this I have no doubt that it is a good species.

24.—E. patens (Benth.).

The common "Blackbutt" of South-Western Australia.

In my trip it first appeared at about five miles out from Yallingup, going to the Margaret River. It is a large tree, grows in damp land, and has rough bark all over the trunk and branches.

Said bark is soft rather than hard, thick, greyish black. In Western Australia such a bark is called "Blackbutt"; in the Eastern States it would be called ".Woolly Butt." The tree reminded me somewhat of Jarrah in general appearance, but Jarrah bark is less rough.

The juvenile leaves opposite or ternate, from broad to narrow-ovate, large, strictly sessile, cordate and the broader ones auriculate, mostly abruptly drawn at the top into a narrow point often ¼ of an inch long, the thickened margins indistinctly and irregularly crenulate. They have not been previously described and were sent by Mr. Max Koch from the Preston Valley.

25.—E. Todtiana (F. v. M.).

This is a species with a trunk 3 feet in diameter at South Perth. It has narrow juvenile leaves. The branches are very brittle. It is not a commercially valuable timber tree, having a short trunk, with rather brittle, non-durable timber.

26.—E. rudis (Endl.).

A common White, River or Swamp Gum of Western Australia, fond of moist localities, and strongly reminiscent of the eastern *E. Gunii*, Hook. f.

27.—E. redunca (Schauer).

The typical form of the species is known as "Black Marlock," and is a dwarf scrubby shrub spreading freely over the Kalgan Plains. Juvenile foliage broad, ovate-acuminate, petiolate venation well marked, intramarginal vein at a considerable distance from the edge, pinnately veined. Long opercula. Cream flowers whose filaments dry brownish or brownish red. Said to be a constant associate of Poison (*Gastrolobium velutinum*, Lindl.).

Var. **elata,** Benth.

This is the "White Gum."

It is the commonest tree about Broome Hill, where it attains a good size. The local people speak of it as the most valuable timber in Western Australia.

It is common near the Kalgan River. It forms very large trees, with white, smooth bark, with grey patches. The timber is red and interlocked, and it is a valuable all-round timber. It is a Jarrah substitute, *e.g.*, for wheel hubs. Enthusiastic people pronounce it to be more durable and even better than Jarrah, when used for posts, etc. Its bark is used as a Mallet adulterant.

28.—E. obcordata (Turcz.).

This species has been recorded from so few localities that specific localities are desirable.

It is abundant at Hopetoun, where it is the commonest Eucalypt near the beach, forming dense masses (thickets) up to 30 feet in height and with a trunk diameter of 4 inches to a foot.

It is erect in habit, with smooth bark, a little ribbony at butt.

Timber hard, brown, with a faint blush of pink when quite fresh.

Egg-in-egg-cup buds. Fruit more angled in some than others.

Some of the *obcordata* in exposed positions at Hopetoun has fruits nearly as dipterous as those of *E. diptera*, Andrews.

The figure on the right-hand top corner of the "Eucalyptographia" plate of *Eucalyptus obcordata* is nearly the type of that species.

E. obcordata is known as "Laurel Gum." Smooth bark, grey streaks, thick round leaf. About 20 feet high. Largest about 14 inches through. Usually in dense thickets. "'Moort' of the aborigines" (F. M. Bee, near West Mt. Barren, correspondent of Dr. A. Morrison).

It forms a tree of 30-40 feet, with smooth scaly bark, 140 miles east of Kalgoorlie, on the Transcontinental Railway Survey, collected by Mr. Henry Deane, Consulting Engineer to the Commonwealth Government. This brings this species some hundreds of miles further to the east.

The word "Maalok" quoted for this species in "Eucalyptographia" (it might just as well be written "Marlock") is not specific. It means a thicket and is used in much the same sense as Mallee is used in the Eastern States. There are various qualifying adjectives, such as Black, White, etc.

Var. **nutans,** Benth. B. Fl. III. 235 (E. Nutans, F. v. M.)

Thin shrub of 6-8 feet growing in small masses but not a true Mallee. Filaments of flowers dull crimson, anthers yellow.

Kundip, 20 miles north of Hopetoun.

This is the plant figured as *obcordata* in the "Eucalyptographia." In the original description of *E. nutans* Mueller describes it as "filamentis rubris" and it is a beautiful small species for a shrubbery.

29.—E. occidentalis (Endl.). (The Flat-topped Yate.)

I will describe three proposed new varieties of this species, viz., var. *astringens* (the Mallet) and vars. *spathulata* and *macrandra.*

The true Yate is *E. cornuta*, Labill. It is sometimes called "Black or Hill Yate" in contradistinction to the "White or Swamp Yate," which is *E. occidentalis.* The branches of the latter are whiter than those of the Black Yate.

The term "Flat-topped Yate" is not in use at the Porongorups, so far as I could ascertain. It is, however, coming into use as applied to the Mallet Bark tree, although the Swamp Yate is flat-topped also. The term "Flat-topped Yate" is in use for *E. occidentalis* in other parts of the State.

"Mr. Muir noted a variety of Yate which has the mass of its foliage flat-topped" (Mueller in "Forest Resources of Western Australia," p. 8).

The name Yate as applied to more than one species has caused some confusion. Mueller, in "Eucalyptographia," calls *E. occidentalis* the "Flat-topped Yate," but apparently in the passage just quoted he looked upon *E. cornuta* as having a flat-topped form, but I did not see, nor could I hear of such a form of *E. cornuta.*

E. occidentalis is a polymorphic species. Dr. L. Diels (Engler's *Bot. Jahrb.* xxxv, 442) described a variety *eremophila.*

There are two forms whose chief distinction appears to lie in the bark, viz., the "Flat-topped or Swamp Yate," and the "Mallet." Endlicher's description of the species throws no light on the character of the bark, but I think it is a fair assumption that the "Flat-topped Yate" is referred to. This is the tree well-known for many years, and I describe its appearance as follows :—

"An erect tree with flat tops. The bark blackish and furrowed (on the lower half of the trunk), then flaky or feathery with black twisted strips, like a French fowl, for approximately the remaining half, then with smooth branches.

The timber brown with gum veins."

Mueller's description of the bark of the species in the "Eucalyptographia" does not take cognisance of that of two forms.

What appeared to be a dwarf form of the "Flat-topped or Swamp Yate" I found on the descent from the Porongorups foot-hills to the Kalgan Plains, and bearing the local name "Bastard Yate." It consists of thickly disposed saplings 10-15 feet, very tough, used as whip handles. With Mallee-like stocks, and the foliage and twigs with a slightly glaucous look.

Var. *astringens*, var. nov

We now come to the form which has come into prominence during the last few years because of the commercial value of its bark, known as "Mallet."

I reiterate that I could not find any botanical difference in flowers and fruits between this and the "Flat-topped Yate," but the Mallet is invariably smooth-barked and valuable as a tan-bark, while the "Flat-topped Yate" has a rough bark, which is economically valueless at present.

I propose the variety name *astringens* for the Mallet, as it seems very desirable to have a distinctive name for it, and I give a few notes on the tree. I will take another opportunity of dealing with the Mallet from an economic point of view, for I spent a good deal of time investigating it.

It is a *Gum*, i.e., it has a smooth bark in contrast to that of the Swamp Yate. It is erect in habit. The bark has more or less of a leaden colour externally, and as the older skin cracks and flakes away, it becomes in patches almost white. It usually contains a more or less well defined layer of brown kino which is quite evident to the eye, and the fracture discloses such. The presence of this kino is used as a diagnostic character in the trade.

The timber is tough, and of a pale brown colour. It exudes, particularly when wounded, a friable kino of a brown colour.

The sucker leaves are broadish and slightly glaucous.

Swamp Yate and Mallet sometimes grow side by side and yet preserve their individuality.

Mallet strippers and others whom I have consulted over large areas, pooh-pooh the idea of the two trees being identical.

We have also what I call Mallet Scrub. It is specifically identical with the Swamp Yate and Mallet tree, but it forms dense masses of spindly stems where I saw it, and I saw it in many places on the Kalgan River and plains; it is not of any size, and affords another instance of a tall tree being represented by a shrubby form.

I refer this Mallet Scrub to *E. occidentalis.*

Var. *macrandra*, var. nov. (*E. macrandra*, F. v. M.)

Forms a thicket of Marlock 4-8 feet high on a slope of Gaalgugup Hill, Kalgan Plains.

Suckers bright green on both sides, ovate acuminate, apparently similar to those of *E. occidentalis.*

Branches brittle. Very long opercula, bulging a little at the top.

Fruits conoid, slightly angled, not urceolate or scarcely so, usually three valved, capitate or with very short pedicels. Tips of valves not exsert, or only slightly so.

"*E. macrandra*, F. v. M. (*B. Fl.* iii, 235) is an extreme form of *E. occidentalis*, exhibiting elongated calyces on hardly any stalklets with very long stamens, and generally smaller fruits with very short fruit valves" ("Eucalyptographia," under *E. occidentalis*).

One of the objects of my trip was to try and find this and other little known forms in the field. I propose the name var. *macrandra* for it.

Mr. O. H. Sargent, of York, sends me his No. 707 from the salty bed of the Salt River, about 10 miles east of County Peak, near Beverley. It seems nearest to var. *macrandra*, but the fruits are stalked. No doubt other forms of this variable species will be found.

Var. **spathulata,** var. nov. (**E. spathulata** Hook. f.)

A dense scrubby growth 4-6 feet high (Marlock), with conoid, angular fruits, flattened foot-stalks, buds egg-in-egg-cup, and narrow or spathulate leaves.

The second growth foliage is very much more spathulate than shown by Hooker in *Ic.* 611. I, however, picked from the same clump of shrubs specimens precisely similar to those in Hooker's figure and also some strictly spathulate 5 cm. long and rather more than 2 broad. They are all thick and coriaceous, and the venation appears to be not dissimilar to that of *E. occidentalis.*

It is rather common near the Kalgan River (Porongorup to Stirling Range). I have received it also from Broome Hill (Dr. A. Morrison).

Mueller looks upon this as an extreme form of *E. occidentalis*, and, after careful consideration, I agree. It is another instance of a fruticose form of a species well known in tree-form ; var. *macrandra* is another fruticose form, and examination of my suite of specimens of that variety has convinced me that the two varieties are closely related and that neither can be usefully separated from the normal species. I will bring the connecting links out in due course in my "Critical Revision," illustrations being helpful.

Mueller did not name this form, but it is so different in appearance both in the field and herbarium from *E. occidentalis* that I think a name is justified.

30.—E. cornuta (Labill.). "The Yate."

A young tree is a Grey Gum, *i.e.*, with bark not so smooth as a White Gum.

A tree of medium size, is spreading in habit, and has rough, boxy, fibrous, dark bark, with vertical fissures close to each other, limbs ribbony and smooth.

An old Yate is a large tree and is something like an Iron-bark on the butt. Indeed, it is sometimes called an Ironbark for this reason. There is no true Ironbark in Western Australia. Beyond the butt,the first large branches have bark more flaky, while the smaller branches are smooth or nearly so.

At maturity it becomes a large spreading tree, fond of creek sides.

It is considered to be the toughest of Western Australian woods and the honey produced by the flowers is good.

I found it at Lower King River, Porongorups, Kalgan Plains, etc.

31.—E. calophylla (R. Br.).

The commonest "Red Gum" of Western Australia.

It is reputed to flower every alternate year, and it yields the best honey.

The leaves slightly perfoliate in the young state. There is caoutchouc in the young leaves.

Miss Bussell, of Ellensbrook, informed me that Red Gum blossom is called "Booneet" by the blacks. They state that when it is in flower the Groper comes into the reef, so that the blacks can spear them. They make a somewhat similar observation in regard to the plant they call "Whale's Eye" (*Candollea cuneiformis*, Labill.).

In bark and general appearance the Red Gum resembles the Bloodwoods of the East. Red Gum is a pale coloured timber with abundant gum-veins (in this respect also resembling Blood wood).

I noticed fruit cases made with Jarrah ends and Red Gum sides. At a little distance the pale wood in a fruit case resembles Pine.

32.—E. pleurocarpa (Schauer). (**A. tetragona,** F. v. M.)

The seedlings have the leaves decussate, glandular and glandular-hairy on branches and along margins of leaves, and also on the backs of the midribs. The branches are very square and the whole plant reeks with oil.

The leaves when young always stalked—flattened stalked—and the young foliage is plum-coloured.

It is a shrub, always straggly, sometimes attaining a height of 10 feet. It is known as "White Marlock," and is a striking object.

Owing to the dazzling whiteness of the plants, the cream coloured flowers are by no means conspicuous, neither are they large. The colour of the filaments is cream, the anthers are small, and the stamens are in bundles (Eudesmiae).

It is common from Hopetoun to near Ravensthorpe, also common on the Kalgan Plains.

33.—E. eudesmoides (F. v. M.).

A White Gum, a smooth-barked straggling tree of 20 feet, with a diameter of 9 inches and very little scaly bark. As a rule seen as a bush.

Wood pale chocolate brown towards the heart, but most of it white.

Branchlets brown, giving the tree a brownish cast.

Juvenile leaves lanceolar, rarely broad.

Leaves pale-green, glaucous, equally green on both sides. Leaves in opposite stage to top of tree. It is the exception for them to be alternate.

Fruits yellowish, quadrangular.

I only came across it at Minginew, where it is rare.

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THE

JOURNAL

OF THE

NATURAL HISTORY & SCIENCE SOCIETY

OF

WESTERN AUSTRALIA.

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The Author of each Article is alone responsible for the facts and opinions recorded.

VOLUME THE FOURTH.

1912.

Printed for the Society by
V. K. JONES & CO., HAY STREET, PERTH.
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Price, Two Shillings and Sixpence.

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THE JOURNAL
OF THE
NATURAL HISTORY & SCIENCE SCCIETY
OF
WESTERN AUSTRALIA.
VOL. IV.

SUMMER TEMPERATURES OF THE SOIL IN RELATION TO THE SUPPLY OF AVAILABLE NITROGEN IN THE WHEAT AREAS. By W. CATTON GRASBY, F.L.S.

(Read February 14th, 1911.)

ABSTRACT.

(Printed in full in the *West Australian*, February 17th, 1911.)

The importance of combined nitrogen as a plant food could not be over-estimated, it being the most costly of all fertilisers, but it was an interesting fact that in connection with wheat growing in Australia, the use of nitrogenous fertilisers had proved to be so far unnecessary. The soil was not an inert dead substance, merely consisting of decomposed rock, for it owed its fertility very largely to the organic matter it contained, which supported a prolific microscopic flora and fauna. It had been known for a considerable time that heating soil to a temperature sufficient to partially sterilise it resulted in a wonderful increase in productiveness, and this knowledge had been made use of by nurserymen in preparing soil for raising seedlings. The reason for this remarkable result was investigated by Drs. Russell and Hutchison, and the results of their investigations were contributed to the "Journal of Agricultural Science" for October, 1909. The researches of these gentlemen showed that they found that soil which had been treated to a process of partial sterilisation, either by heat or by an antiseptic, was characterised by an exceptional accumulation of ammonia. They also discovered that, contrary to accepted opinion, plants were capable of absorbing and utilising nitrogen in the form of ammonia and that this increase in nitrogen was sufficient to account for the added fertility. The researches also disclosed the act that the partial sterilisation was associated with the

cessation of the nitrifying process, but it was evident that the increase in the amount of ammonia was not simply due to this fact. Extended research enabled them to demonstrate that partial sterilisation, while it destroyed many forms of bacterial and other microscopical life, did not completely destroy the bacteria responsible for the production of ammonia, and that after treatment these bacteria increased with marvellous rapidity, which accounted for the increase in ammonia. Investigation into the reason of this showed that in ordinary soil micro-organism of the protozoa family, of relatively large size as compared to the ammonia producing bacteria, devoured the latter and prevented their rapid increase. Partial sterilisation completely destroyed the protozoa, thus allowing the ammonia-producing bacteria a free field for rapid increase.

Saprophytic micro-organisms tend to increase the fertility of the soil, because they produce ammonia, fix nitrogen, and so on, although some of them are, under certain conditions, injurious because they bring about a liberation of free nitrogen. A second class of organic life known as phagocytes consume living bacteria. These two classes of organisms act and react on one another, according to the same law which operates among the more highly organised animals and plants all around us. This discovery explains facts which had long been known, that heating and drying the soil results in increased productiveness.

Dr. Hutchison, writing to Mr. Grasby, stated that:

> "exposure of soil to a moist heat of 130 to 140 degrees Fah. for from one to two hours has been shown to be sufficient to destroy protozoa in soils, while higher temperatures tend to increase fertility by gradual decomposition of the organic matter of the soil."

Professor Warrington, in his book on the "Physical Properties of the Soil," states that for the greatest amount of solar heat to reach the earth the air must not only be clear but dry. In the case of the bare dry soil freely exposed to the sky the range of temperature at the surface is very great—far greater than that of the air above it. Sir J. F. W. Herschel sunk a thermometer 4 in. deep in South Africa and observed the temperature to rise 150 deg. Fah. Schubler placed a thermometer one-twelfth of an inch below the surface of soil in Germany, and the highest temperature observed during two years was 158 deg. Fah. The same experimenter found that the black soil quite dry became 13 to 15 deg. warmer than white soil.

On February 1st of the year (1911) the official record at Guildford gave a shade temperature of 107.7 deg. Fah. Between 1 and 2 o'clock that day he took records in his garden with a dairy thermometer, which may be considered correct within one degree. Placed ½ in. below the surface of dry coarse sand the reading was 134 deg. Fah., and ½ in. under dark sandy loam it was 148 deg. On February 13th, when the air temperature at Guildford was 91 deg. Fah., and the solar reading 143 deg., an accurate thermometer registered 150 deg. Fah. half an inch below the surface of dry dark loam, and 120 deg. Fah. at a depth of 5 in. In the same spot the same thermometer covered with half an inch of powdered slaked lime recorded 120 deg., or the same as at a depth of 5 in. in dark soil. In another place under light grey soil the reading was 130 deg. half an inch below the surface, and 100 deg. 5 in. down.

Unfortunately, the regular observations made by the Meteorological Department did not assist much in the present study. Soil temperatures are taken regularly at 8 or 9 in., 3 ft., 5 ft., and 8 ft., below the surface, but no records are available for the surface soil to a depth affected by cultivation. At Perth the maximum at 8 in. was 86 deg. on February 27th, 1907, the shade temperature being 90.8 deg. The monthly readings at 8 in. do not vary much. Although solar temperature records are not considered very reliable, they are a good guide for the present purpose. On November 19th, 1910, the solar reading at Charlotte Waters was 198 deg. Fah., while the shade temperature was 112.2 deg. Fah. In January, 1908, the solar readings at Eucla ranged from 167 to 179 deg. seven times. The mean yearly solar temperature at Coolgardie is 138.5 deg. Fah. The Commonwealth Meteorologist thinks that it is fair to assume that rock surface exposed to the sun may reach anything from 160 to 200 deg. Fah.

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Mr. Grasby suggested that it might be reasonably assumed that the combination of summer dry heat, followed by the vivifying rains while the soil was still warm, afforded the necessary conditions described by Drs. Russell and Hutchison, and it was desirable to have observations made in the wheat areas. If possible the temperature of the soil should be read at 1 in. and 5 in. below the surface. The colour and character of the soil should also be mentioned. The character does not appear to matter much, but it would be best to state whether it was sand, loam, or clay.

BIRD DAY—A PLEA FOR THE PROTECTION OF BIRDS. By J. G. HAY (Read March 14th, 1911).

NITROGEN IN THE ECONOMY OF NATURE. By M. A. MAURICE BROWNE. (Read May 9th, 1911).

SOME GEOGRAPHICAL ERRORS AND THEIR INFLUENCE UPON EXPLORATION AND SETTLEMENTS. By J. G. HAY (Read May 9th, 1911).

RELICS OF THE PERMO-CARBONIFEROUS ICE AGE IN WESTERN AUSTRALIA.* By A. GIBB MAITLAND, F.G.S., BEING THE ANNIVERSARY ADDRESS OF THE PRESIDENT. SESSION 1910-1911. (Delivered July 11th, 1911.)

PLATES I—XI.

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INTRODUCTION.

My acceptance of the position of your President involved, amongst other things, the very responsible duty of delivering an anniversary address at the close of my term of office. I wish, in the first place, to express to you all my deep sense of gratitude for the honour which you conferred, not, however, on myself personally, but rather upon that field of scientific investigation in which I have laboured for the last quarter of a century. Such being the case, the appropriateness of devoting a little time to the consideration of observations, on some special department of geological science, has naturally suggested itself as being that which is expected from your President, besides being more or less in accordance with traditional usage in like circumstances.

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* Owing to causes beyond the President's control the delivery of the Anniversary Address was deferred to this Session.

Considerable attention has recently been and is now being given to the Antarctic region, and its varied glacial phenomena, hence it seemed to me that, as a portion of Western Australia has been subject to all the rigours of an Arctic climate during one period of its geological history, a brief account thereof might perhaps be appropriate at the present time. I, therefore, purpose directing your attention for an academic hour to an account of the relics of the Permo-Carboniferous Ice Age occurring in Western Australia.

The bulk of the rocks of Western Australia have, up to the present, derived their importance from their real or potential economic value, whilst the Permo-Carboniferous glacial deposits owe their chief importance to purely scientific considerations, though they do mark very important geological horizons bidding fair to make them valuable bench marks, which materially assist in the development of the resources of those widespread districts in which the deposits occur.

Discovery of the Glacial Conglomerates and their Recent Studies.

In the year 1897 I made a traverse up the Murchison Valley in an exceptionally dry season, when considerations of grass and water very seriously interfered with geological investigations. At a point in the river near the Fourteen Mile Crossing, a bed of conglomerate, dipping at a low angle to the east, was exposed—a peculiar feature, which immediately attracted my attention was that many of the component pebbles were found to be covered with scratches of such a nature as to suggest that they owed their origin to ice-action. A few yards lower down were beds of cross-bedded sandstone and fine conglomerate dipping east at an angle of about 20 degrees. One of the beds had been scored to such a degree as to produce surfaces as smooth and polished as plate glass, though they did not present the clearest evidence of ice-action, it is quite possible that this may be a glaciated pavement.

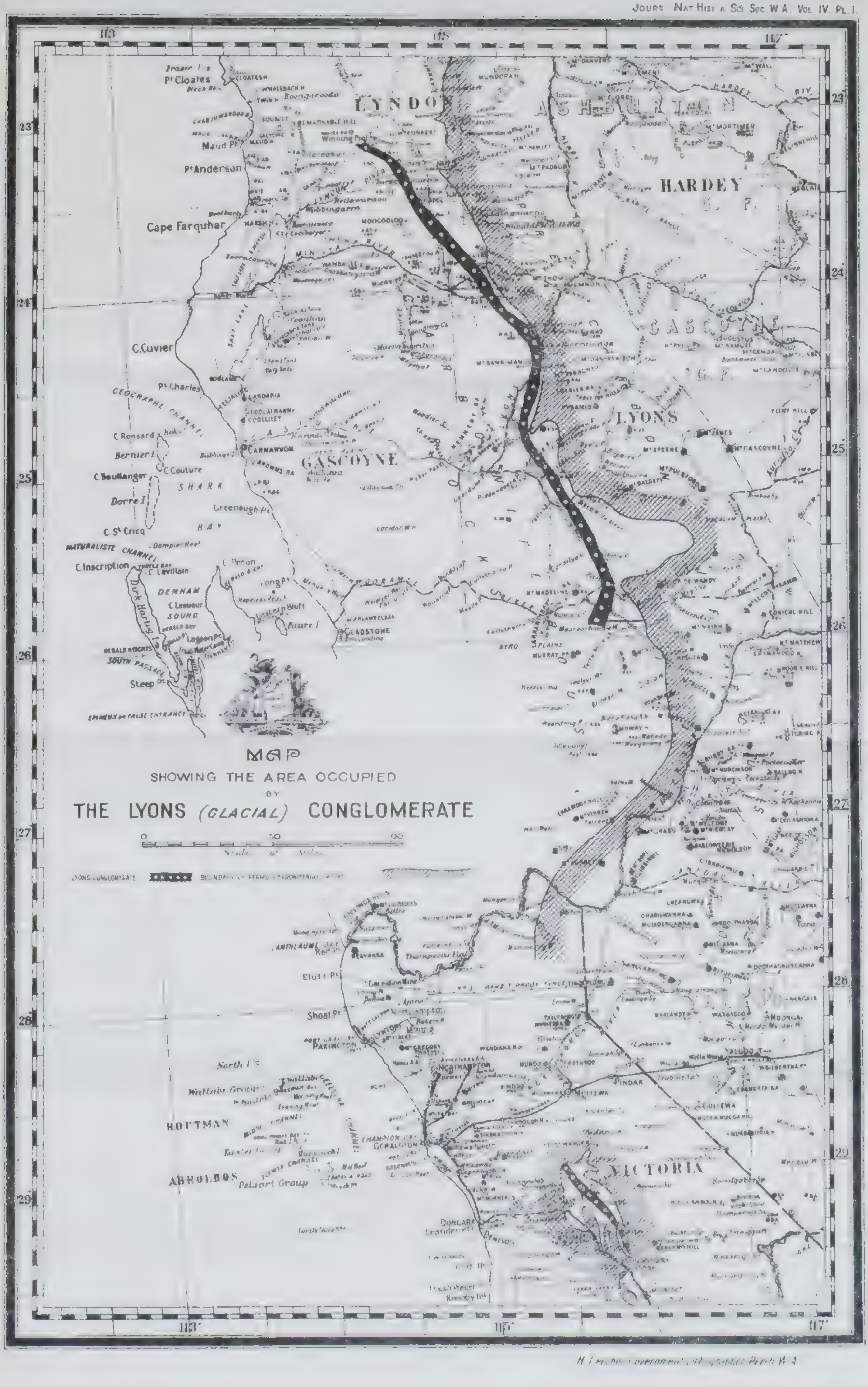
Some distance up the Murchison River, near the Forty-mile Crossing and Water Reserve 1005, the strata consist of sedimentary beds, interstratified with coarse conglomerates or boulder beds; though such a careful search as circumstances permitted was made, no undoubted ice-scratched or striated-boulders were detected in this locality. The important point in connection with these conglomerates containing the scratched boulders and the striated rock surface, is that they form the southern extension of the Permo-Carboniferous Series of the Gascoyne, and constitute a connecting link between the latter and the Irwin River Beds, in both of which sections the glacial boulder bed occurs in all its grandeur,

In the same year, 1897, I paid a visit to the Irwin River district in connection with proposals to test the seaward extension of the Coal Measures by boring. Beneath the coal seams are calcareous shales and limestones, containing a series of fossils, the facies of which is more akin to the Carboniferous than the higher Permo-Carboniferous. I found associated with the marine series a boulder bed the debris of which strew the surface for a considerable distance, but no undoubted striated pebbles were detected, at that time, among the boulders.

It was not, however, until four years later that definite proof of the glacial origin of certain beds in the Permo-Carboniferous Series of Western Australia was forthcoming. In the year 1900 a geological reconnaissance was made by myself between Cue and Carnarvon, in connection with investigations as to the artesian water possibilities of the Gascoyne River valley. The sections exposed extended from the fundamental Archaean complex beneath to the Mesozoic beds above, and in the valleys of the Wooramel and the Minilya Rivers, near the Tropic of Capricorn, there was discovered an extensive deposit of undoubted glacial origin, which was traced across country for about sixty miles. The stratigraphical position of the conglomerate showed it to be not very far from the base of the series as developed in this locality.

The field season of 1907 afforded me a much better opportunity of examining these beds in greater detail, when travelling between Carnarvon and Roebourne, investigating the mineral resources of the country between these two places. The results of this reconnaissance showed the northern limit of the glacial conglomerate to be on the Lyndon River, in the vicinity of Tchugareywurdoo Pool, and thus proved the bed to extend as a narrow band for a distance of about 200 miles in this portion of the State, between latitudes 23° and 26° south.

The geological survey of the Irwin River Coal Field, completed by my late colleague, Mr. W. D. Campbell, in 1908, has added very considerably to our knowledge of the Permo-Carboniferous Series, and has resulted in the discovery of a glacial boulder bed of some considerable importance, which extends for a distance of about twenty-four miles. This glacial conglomerate does not occupy any great area, being unconformably overlaid by a considerable thickness of Jurassic strata. The area though relatively small affords us much additional information with regard



MAP

SHOWING THE AREA OCCUPIED

BY

THE LYONS *(GLACIAL)* CONGLOMERATE

H. J. Pether Government Lithographer Perth W.A.

to the character and disposition of the glacial conglomerate.

Having dealt in brief with the history of the discovery of this important glacial horizon, it now becomes convenient to proceed to the real object of the present address, which is to give some account of the results which have been obtained; for this purpose it will be more convenient to disregard strict geographical sequence and to describe the Gascoyne River valley section first. [Plate I.]

THE GLACIAL CONGLOMERATE IN THE GASCOYNE VALLEY.

The valley of the Gascoyne River, from its mouth for a distance of about 130 miles, to a point a few miles below its junction with Dalgetty Brook, is occupied by strata of Palaeozoic, Mesozoic, Tertiary and Post-Tertiary Age. These strata have been pierced in the pioneer bore at Pelican Hill, near Carnarvon, which had been carried down to a depth of 3,011 feet. The first 150 feet comprise rocks of either Newer or Post-Tertiary Age; Middle Tertiary rocks (the age of which is based on evidence of specimens of bryozoan limestones) were passed through to a depth of 1,238 feet; Mesozoic (and possibly Cretaceous) rocks continued down to 1,361 feet; whilst the last 1,650 feet penetrated beds as determined by their fossils to be of Permo-Carboniferous Age. The latter strata are represented by calcareous shales and limestones, the cores of which have yielded specimens of *Spirifera*, *Aviculopecten*, *Anthrocoptera*, and *Favosites*. The bore hole, however, did not pierce the whole thickness of the Permo-Carboniferous rocks, though the basal beds may be seen some 130 miles higher up the Gascoyne River.

Wherever these Permo-Carboniferous rocks have been examined in Western Australia it has been found that the formation can everywhere be divided into a lower or limestone series (in which limestones predominate), and an upper or sandstone series (made up largely of sandstones and other sedimentary beds).

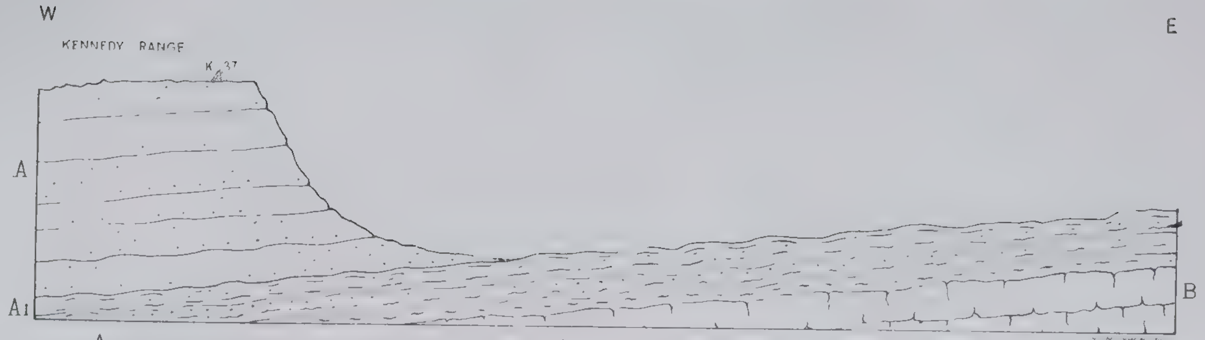
The upper or sandy series is well developed in the Carandibby, Kennedy and Moogooloo Ranges (Plate II, Fig. 1), making a more or less continuous bold escarpment about 200 miles in length, and which rises to a height of about 350 feet above the general level of the surrounding country. These sandy beds, some of which are highly ferruginous, have yielded fragments of the fossils *Spirifera*, *Productus*, *Athyris* and *Strophalosia*, cross the Gascoyne River, near the Shipka Pass. In the valley of an important tributary of the Lyons River, which in the lower portion of its course flows at the foot of the great Kennedy Range escarpment, there are many sections which show the nature of the beds beneath the sandy series. They consist of a thickness of fossiliferous limestone, which dips at gentle angles of from 5° to 8° to the westwards. This limestone, which can be followed by the eye across country for a great many miles, is the equivalent of that met with in the deep bore at Pelican Hill, near Carnarvon. Many excellent exposures of it are to be seen in the range through which the Wyndham and Arthur Rivers flow. A very fine section of this limestone is to be seen in the gorge through which the Wyndham River passes, near Survey Traverse Station, No. 56. The sections in the Arthur River above the range give a fairly complete section of the basal members of the Permo-Carboniferous Rocks, and are in addition of considerable scientific importance. Between the Arthur Gorge and Barragooda Pool there are one or two exposures of the glacial boulder bed, which is seen to lie beneath the fossiliferous limestone.

As it will be convenient to have a name by which to designate this important geological horizon, it is proposed to use for it the term "Lyons Conglomerate," which is the official designation of the Land District in which it was first discovered, and where it is so well developed.

Figure 2, Plate II, gives a section of the strata in the valley of the Arthur River, showing the stratigraphical relationship of the boulder bed. A section on the southern bank of the Arthur River shows large striated boulders embedded in a very calcareous clayey matrix; the bed, as may be seen in the photograph (Plate III, Fig. 3), is not very thick, but by weathering *in situ* its débris occupies a width in places of about a mile. It is very seldom that the bed is actually seen *in situ*, though its presence is always indicated by the heterogeneous collection of boulders, which strew the surface and which result from its weathering. The various rocks which form the boulders in the "Lyons Conglomerate" consist of quartzite, granite and basic rocks, of the type which characterises the older strata immediately underlying the Permo-Carboniferous beds outcropping to the eastward.

The boulders and fragments are of all sizes from an inch up to several feet in diameter; some of the pebbles are beautifully striated; a photograph of a scratched quartzite pebble from this locality is shown in Figure 4, Plate III.

The thick stratum of limestone above the boulder bed in the Arthur River contains such a series of fossils as clearly indicates its geological horizon, viz.:—*Evactinopora*

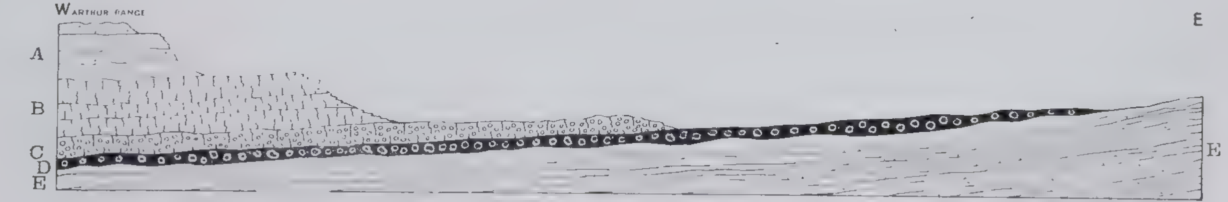


A SANDSTONES GRITS AND FINE CONGLOMERATES A1 FLAGGY SANDSTONES AND SHALES B LIMESTONES

SECTION ACROSS THE LYONS RIVER VALLEY

NOT TO SCALE

Fig. 1.



A GRITS AND FINE CONGLOMERATE. B FOSSILIFEROUS LIMESTONE. C LIMESTONE CONGLOMERATE D. GLACIAL BOULDER BED. E. SANDY AND FLAGGY LIMESTONES

SECTION IN THE ARTHUR RIVER VALLEY

Fig. 2.

NATIONAL MUSEUM OF [illegible]

NATIONAL MUSEUM MELBOURNE

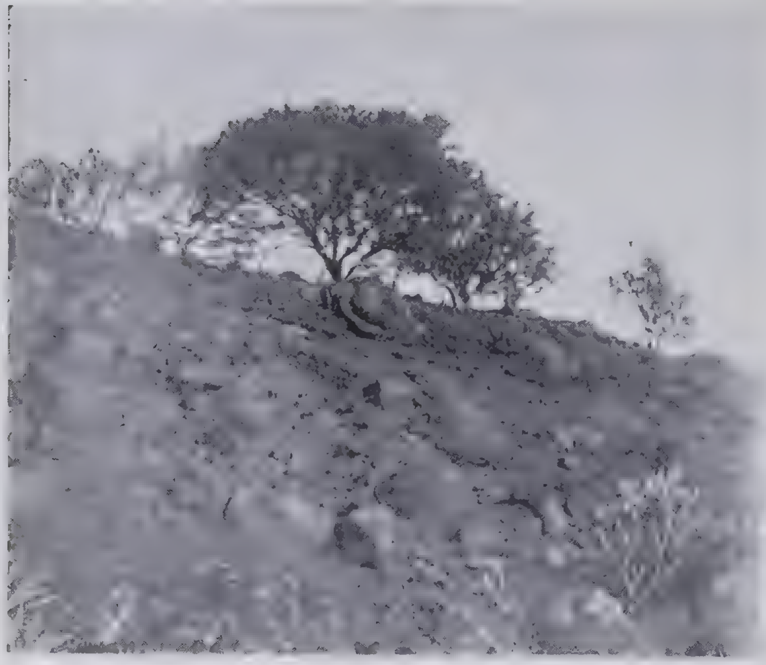
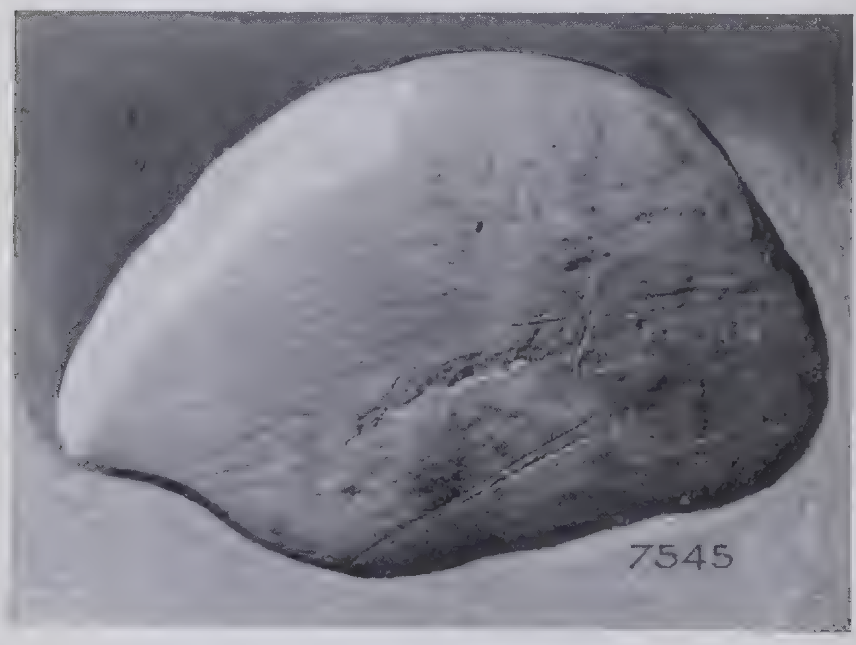


Fig. 3.
Section of the Boulder Bed in the Southern Bank of the Arthur River.



crucialis, Hudleston ; *Rhombopera tenuis*, Hinde ; *Athyris Macleayana*, Eth. Fil. var. ; *Productus semireticulatus*, Martin ; *Aulosteges*, sp. nov. ; and *Dielasma*, sp. nov.

At a point in the Wyndham River just north of the Range, through which it has cut a channel, is another section showing the boulder bed (Fig. 5, Plate IV). The deposit, which does not attain any greater thickness than three feet, is crowded with boulders and pebbles of granite and crystalline rocks embedded in a calcareous fossiliferous matrix (Fig. 6, Plate V), which contains fragments of *Spirifera*, *Productus* and *Polyzoa*, in addition to *Aviculopecten tenuicollis*. The bed in which these pebbles and boulders occur is, beyond all doubt, of marine origin, as is proved by its fossil contents ; it therefore can hardly be a glacial moraine, and it is more than likely that the materials of which the bed was made up were transported by floating icebergs, that drifted seawards after they had been broken off from some extensive glacier which came down to sea level.

It is well known that whenever glaciers descend to sea level, and extend into the sea, huge icebergs break off and float away. These icebergs are often loaded with débris of all kinds of rocks, and very great physical results must ensue from the scattering of such large quantities of material over the sea bottom. Antarctic icebergs also carry a similar burden, and glacial conglomerates are actually forming at the present time.

One of the Arctic navigators, Col. Fielden, in an account of his visit to the Kara Sea, off Nova Zemblya, in the years 1895 to 1897, gives a graphic description of how at the present day icebergs may be seen loaded with debris of every conceivable kind. This author emphasises the effects which must ensue from the annual transport of burdens of mud, shingle and sand, which are carried by the ice-floes and distributed over the floor of the ocean. In north latitude 69° 40′, and east longitude 57° 12′, Col. Fielden encountered numerous icebergs covered with gravel and silt. In Dolga Bay, while scrambling over the dripping, rolling and melting pack-ice, this observer was very forcibly impressed with the enormous quantities of detritus, stones, gravel and mud on the surface of the floes, and which on melting was thrown to the bottom of the sea. It is impossible to estimate the amount of material thus transported into the Kara Sea, but from Col. Fielden's account it appears not only to have been enormous, but during the course of ages must have exercised great influence in decreasing the depth of that sea and forming beds not unlike the Lyons Glacial Conglomerate. Marine boreal beds appear to be very conspicuous in the Kara Sea, and extend for many miles to the north and south. They consist of thick beds of clay and sand often crowded with erratics, many being of immense size and often beautifully polished, grooved and scratched. In the neighbourhood of Belusha Bay are vast stretches of these beds at an elevation of about 500 feet above the present level of the sea; they contain shells and foraminifera of the same species as now abound in the neighbouring waters, thus demonstrating their marine origin. On the summits of some of the surrounding mountains 800 feet in height are erratic boulders of granite and foreign rocks, whose presence is ascribed by Col. Fielden to floating ice.

It may in this connection be of interest to point out that Sir Jas. Ross noticed a somewhat analogous condition of affairs in the Antarctic, when off Victoria Land. This navigator gave an account of the capsizing of an iceberg, which presented a fresh surface found to be covered with large quantities of earth and stones, these latter being deposited on the sea floor by the melting of the berg. H.M.S. *Challenger*, in lat. 65° 42′ S. and long. 79° 3′ E., dredged from a depth of 1,675 fathoms various kinds of rocks and pebbles from a bluish calcareous mud. Very many of the rocks and pebbles showed distinct glacial striae. Boulder-bearing clays and sands of this kind, which owe their origin to the distribution of continental debris carried seawards by floating ice, have been proved by the *Challenger* expedition to be of very great extent in the Antarctic, reaching equatorwards as far as lat. 46° or 47° South.

These observations are of extreme interest as showing that in the circumpolar regions of both hemispheres boulder-bearing clay, mud and sand is at the present time being laid down over a very large area of the ocean floor, and which, if consolidated, would produce beds in every way identical with the Lyons Glacial Conglomerate.

The pebbles and boulders of the Lyons conglomerate as developed in the vicinity of the Wyndham and Arthur Rivers have a very large proportion of smooth and polished faces. The flats in the neighbourhood are covered with boulders and blocks of crystalline rocks derived from the weathering *in situ* of the conglomerate, which in this locality has a dip of about three degrees to the south-west.

In the bed of the Wyndham River, beds of flaggy sandy limestone may be observed passing beneath the boulder bed. Associated with the boulder bed are the following fossils:—*Hexagonella dendroidea*, Hudleston; *Pleurophyllum Australe*, Hinde; fragments of Crinoid stems and Polyzoa; *Spirifera Musakheylensis*, Davidson; *Spiri-*

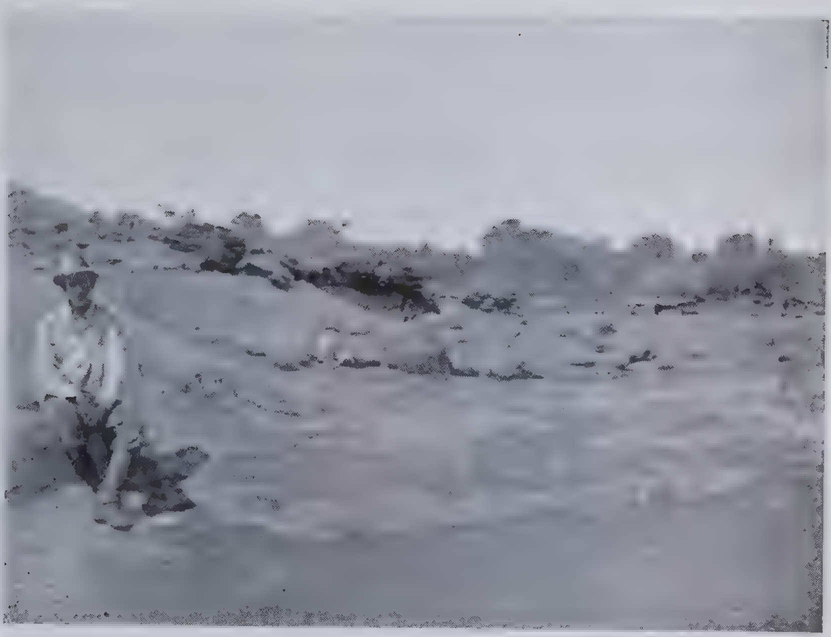


Fig. 5.

Section of the Boulder Bed in the Wyndham River.

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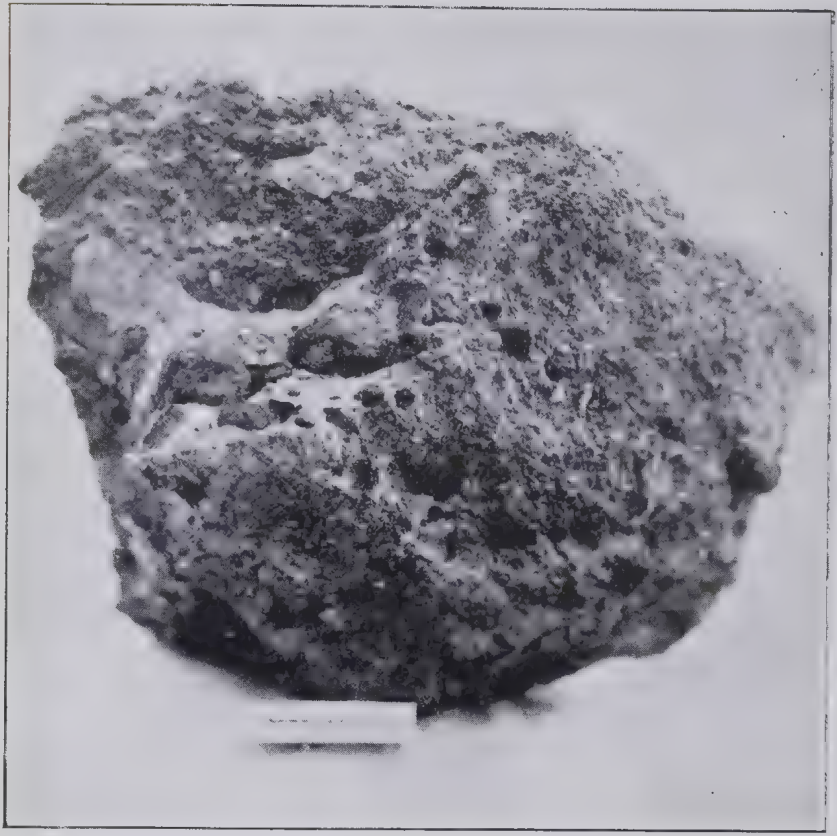


Fig. 6.
Fossiliferous Glacial Conglomerate, Wyndham River.

fera Hardmani, Foord; *Spirifera lata*, McCoy; *Reticularia lineata*, Martin; *Athyris Macleayana*, Eth fil; *Chonetes Pratti*, Davidson; *Productus* (c. f. *P. tenuistiatus*), Foord.

Northwards from the Wyndham River the débris of the boulder bed makes its appearance in great force, whilst the flaggy sandstones immediately underlying it are covered with large boulders of crystalline rocks. The actual base of the Permo-Carboniferous formation is seen in a low isolated hill about three miles to the west of Trigonometrical Survey Station K 32. At this locality a medium-grained quartz-conglomerate is seen to rest upon the upturned edges of the older crystalline schists, which form the platform upon which the newer strata were built up. Other sections in the vicinity show that this platform has a very uneven surface.

The section in the watershed of the Wyndham shows conclusively that the glacial conglomerate does not lie quite at the base of the Permo-Carboniferous Series. A very careful search was made in this locality for glaciated surfaces amongst the older rocks and amid the beds directly underlying the boulder bed, but without success. This, however, is not at all surprising, for the constant alternations of heat and cold to which the rocks of this portion of Western Australia are subjected naturally tends to the very rapid destruction of brittle rocks; consequently, any glaciated pavement would tend to rapidly break up on exposure, and could only be expected in the more immediate vicinity of the glacial conglomerate, where the beds beneath have been exposed in comparatively recent geological times.

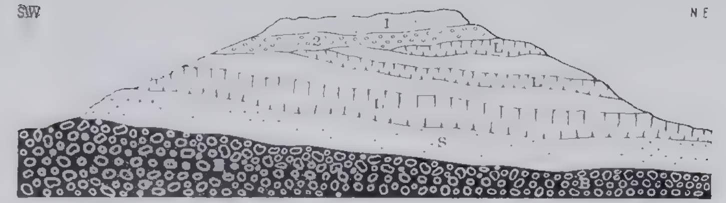
THE GLACIAL CONGLOMERATE IN THE MINILYA VALLEY.

A fairly complete section of the Permo-Carboniferous Rocks is exposed in the valley of the Minilya River, which lies about 80 miles to the north of the Gascoyne. The upper reaches of the river, which only extends some 150 miles inland, drains country made up of the ancient crystalline schists and other associated rocks. In no section in the watershed of this river was the actual base of the Permo-Carboniferous Series seen. Near Trigonometrical Survey Station K34, the Permo-Carboniferous beds were seen to be faulted against the older crystalline rocks; a similar junction was also noted in the two main branches which form the head of the river to the northward. This disruption would seem to indicate a former much more extended distribution of the Permo-Carboniferous Series to the eastward. Some distance to the westward of the junction of the two formations at the latter locality is a very pronounced ridge of limestone trending generally north and south, and dipping to the westward at a low angle. Lower down the south branch of the river in the vicinity of Traverse Stations 64 and 65 the glacial conglomerate appears in very great force. The débris of the conglomerate which strews the surface consists of a heterogeneous collection of all varieties of crystalline rocks, some of which are markedly glaciated. Much further down the Minilya River, near Traverse Station K66, are fossiliferous limestones, which dip at low angles to the westward (Figs. 7 and 8, Plate VI). These limestones have yielded *Cleiothyris Macleayana*, Eth. fil. Beneath these limestones the glacial boulder bed may be seen in many localities, where its presence can be readily detected owing to its weathered débris (Fig. 9, Plate VII).

THE GLACIAL CONGLOMERATE IN THE LYNDON VALLEY.

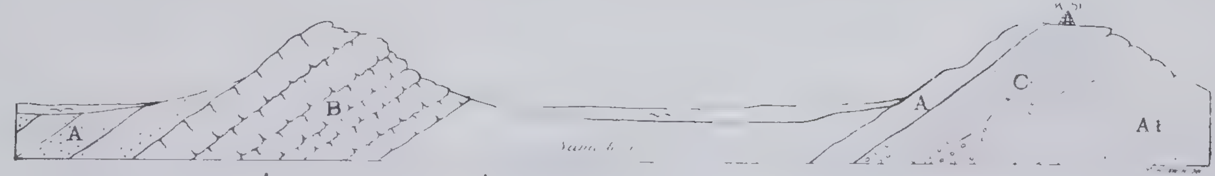
While engaged on the Yanarie River in 1907, opportunity was taken to visit the upper portions of the Lyndon River for the purpose of examining the basal beds of the Permo-Carboniferous Rocks, the existence of which had been reported by my colleague, Mr. H. P. Woodward, in the previous year. What is believed to be the base of the Permo-Carboniferous formation is to be seen some distance to the southward of Tower House, on the Yanarie River, and consists of a quasi-vitreous conglomerate lying practically horizontally upon granite. The only available water at the time I visited the Lyndon River was at Windalia Pool, where the strata exposed consisted of horizontal beds of fine grained clayey sandstone.

A horseback traverse was made to what is shown on all the maps as Tchugareywurdoo Pool, in the vicinity of which a boulder bed associated with limestone had previously been noted. This boulder bed and its débris covers a fairly wide expanse of country, and the boulders consist of a very great variety of rocks, many of them being covered with glacial striae. Wherever this bed was exposed it was found to be in every way identical with that on the Gascoyne, etc., and to which reference has already been made. Its stratigraphical position beneath the fossiliferous limestone shows it to be upon the same geological horizon as the glacial conglomerate of the Arthur and the Minilya Rivers. From Windalia exigencies of travel took me some miles to the southward as far as the dam on Kialawibri Creek, where it is crossed by the road from Maud's Landing. Though no section showing the glacial conglomerate *in situ* was met with, nevertheless its weathered débris was frequently exposed *en route*. The section at Tchugareywurdoo Pool marks the most northerly extension of the glacial conglomerate yet proved in Western Australia.



1 QUARTZ VITREOUS SANDSTONE 2 FINE CONGLOMERATE
L FOSSILIFEROUS LIMESTONE S SANDSTONE B GLACIAL BOULDER BED
SECTION SOUTH OF TRAVERSE STATION L 66 MINILYA RIVER

Fig. 7.



~ SUPERFICIAL DEPOSITS A SANDSTONES & GRIT A1 FERRUGINOUS SANDSTONE B LIMESTONE C PEBBLY CONGLOMERATE

SECTION IN THE MINILYA RIVER NEAR WILLIAMBERY POOL.

NOT TO SCALE

Fig. 8.

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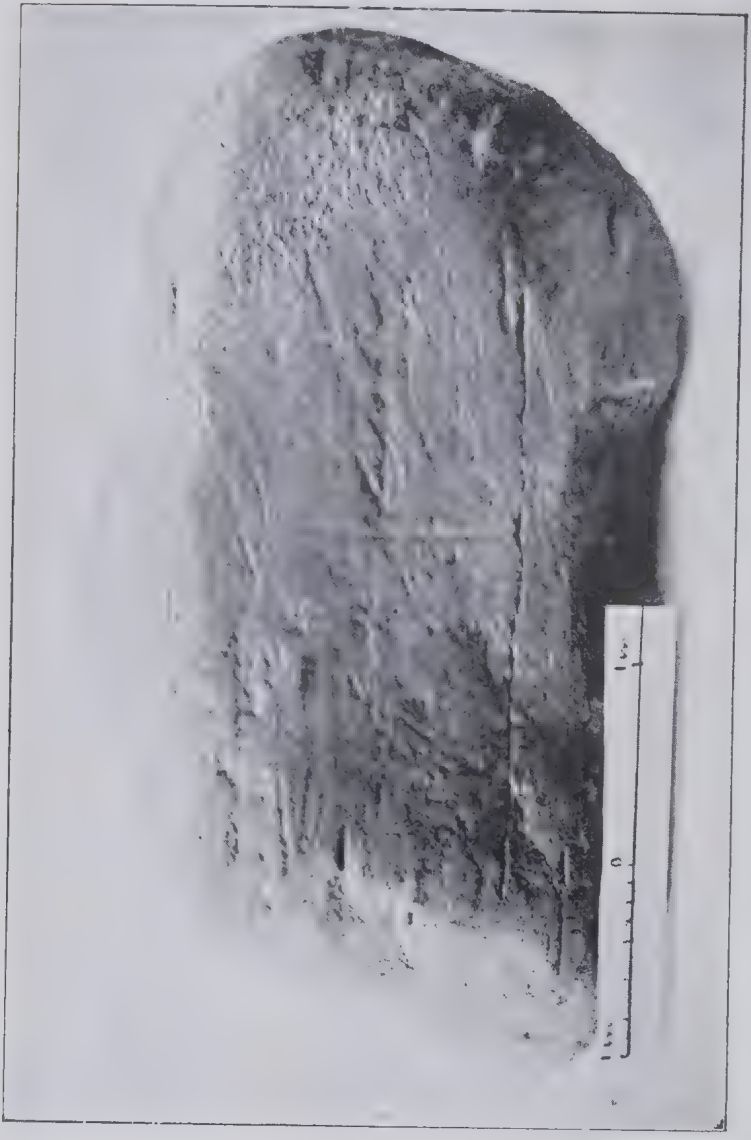

Fig. 9.

Ice Scratched Boulder, Minilya River.

THE GLACIAL CONGLOMERATE IN THE WOORAMEL RIVER.

To the south of the Gascoyne is the Wooramel River, in which at about 130 miles from the coast the lowest beds of the Permo-Carboniferous Series are exposed. The valley of the Wooramel has not been very closely examined, though from a geological point of view it is perhaps one of the most interesting localities, since it is stated that a much better series of rock sections are exposed in its cliffs than in any other river in this portion of the State.

The upper reaches of the Wooramel, between the Carandibby Range and Bilung Pool, are composed of sandy shales, clay shales, sandstones, and limestones. These latter have yielded the following: *Alveolites obscurus*, *Hexagonella crucialis*, *Hexagonella dendroidea*, *Stenopora Tasmanensis*, *Crinoid* stems, *Aulosteges Baracoodensis*, *Orthis* cf. *michelini*, *Productus subquadratus*, *Cleiothyris* (*Athyris*) *Macleayana*, *Cleiothyris* (*Athyris*) *Roysii*, *Dielasma*, *Spirifera convoluta*, *Spirifera lata*, *Spirifera Musakheylensis* var. *Australis*, *Spirifera trigonalis*, *Aviculopecten* spp., *Deltopecten* (*aviculopecten*), *Illawarrensis*, *Myalina* spp., and *Pleurophorus* (*Pachydomus*) *carinatus*.

Bilung Pool, at the head of the Wooramel, is a fine sheet of water formed by the stream falling over an almost horizontal bed of sandstone. Below the pool the watercourse is hemmed in by low cliffs of a shaley conglomerate, which occasionally recede from the river to such an extent as to form large wide flats. Some of these are covered with large boulders derived from the disintegration of the conglomerate. Wherever the beds beneath the conglomerate are to be seen in the flats they are everywhere found to be composed of grey shales.

About half-way between Bilung Pool and the junction of the Wooramel River, the creek breaches a whitish felspathic sandstone, which forms cliffs about 30 feet in height.; beneath this lies the conglomerate (Fig. 10, Plate VIII), to the disintegration of which *in situ* the "boulder flats" are in all probability due.

Some of the boulders are of very large size and made up of rocks in every way identical with the older formations to the eastward.

The stony tableland shown on all the maps as the Byroo Plains, and which is strewn with rounded boulders of quartz and crystalline rocks, probably owes its origin to the disintegration of the glacial boulder bed.

These sections in the upper Wooramel show that the glacial horizon lies below the Productus Limestone in the same stratigraphical position as that on the Gascoyne and the other rivers further to the north. The Wooramel Permo-Carboniferous Rocks pass beneath what are believed to be strata of Jurassic Age, somewhere in the vicinity of the Errabiddy Hills, in the watershed of the Murchison River.

THE GLACIAL CONGLOMERATE IN THE IRWIN RIVER.

The Permo-Carboniferous Rocks do not make their appearance again until the Irwin River valley is reached, about 180 miles to the south of the Wooramel (Plate I). These beds occupy a fairly large area in the valleys of the Lockier and the Irwin Rivers, and the upper portion of Kockatea Creek, but the northern extension of the beds has not as yet been very accurately defined. The strata present an uninterrupted series of shale, clay, sandstone, with occasional limestones, which are arranged in a very broad anticlinal fold, the axis of which trends generally north and south. As is the case in Kimberley and the Gascoyne, it seems possible to divide the strata into two distinct parts, viz., the lower, the limestone, and the upper, the sandstone series. The sandy series is well developed in the vicinity of Mingenew, where, close to the railway line, are a series of ferruginous sandstones, which remind one very forcibly of the sandstone series as developed in the Kennedy Range, on the Lyons River. The Mingenew beds have yielded the following fossils: *Dielasma nobilis*, sp. nov.; *Spirifera*, sp. ind.; *Spirifera avicula*, G. B. Sby.; *Cyrtina carbonaria*, var. *Australica*, eth. fil.; *Cleiothyris Macleayana*, Eth. fil.; *Productus subquadratus*; *Productus brachythoeris*; *Chonetes*, sp. ind.; *Deltopecten subquinquelineatus*, McCoy; *Modiola*, sp. ind.; *Myalina* (?) *Minginewensis*, sp. nov.; and *Fenestella* or *Protoretepora*. On the whole, it seems that the aspect of the fossils from Mingenew is that of the Permo-Carboniferous as developed in Eastern Australia.

Beneath these beds, according to Mr. Campbell's researches, there occurs about the middle of the Carboniferous Series a zone of clay and argillaceous limestones containing very many boulders with smooth surfaces, well defined grooves, and cross scratchings, such as ice action alone can produce. The boulders consist of granite, gneiss, amygdaloidal lava, sandstone and limestone, identifiable with the rocks forming the plateau to the eastward of the main granite range.

The most extensive outcrop of this boulder bed is near Nangatty Homestead, on the western side of the Irwin River The same bed evidently occurs on the south side of the Irwin River, on Location 1,902, where there is a very large quartzite

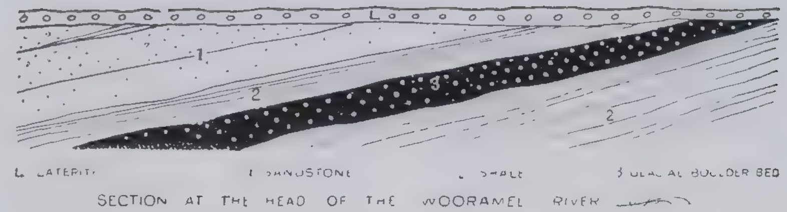
L
1
2
3
2
L LATERITE
1 SANDSTONE
2 SHALE
3 GLACIAL BOULDER BED
SECTION AT THE HEAD OF THE WOORAMEL RIVER

Fig. 10.

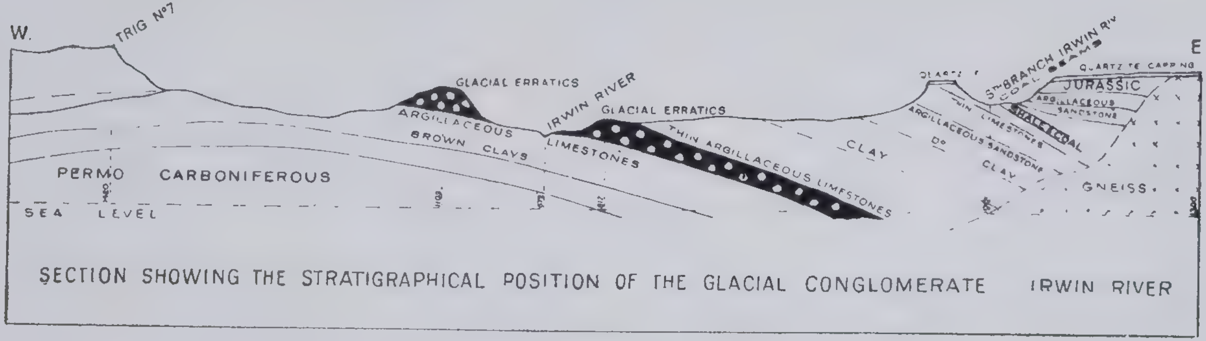
W.
TRIG No7
GLACIAL ERRATICS
IRWIN RIVER
GLACIAL ERRATICS
ARGILLACEOUS
BROWN CLAYS
LIMESTONES
THIN ARGILLACEOUS LIMESTONES
CLAY
PERMO CARBONIFEROUS
SEA LEVEL
QUARTZITE
STH BRANCH IRWIN RIV
COAL SEAMS
QUARTZITE CAPPING
JURASSIC
ARGILLACEOUS SANDSTONE
SHALE & COAL
THIN LIMESTONES
ARGILLACEOUS SANDSTONE
ARGILLACEOUS
Do
CLAY
GNEISS
E
SECTION SHOWING THE STRATIGRAPHICAL POSITION OF THE GLACIAL CONGLOMERATE IRWIN RIVER

Fig. 14.

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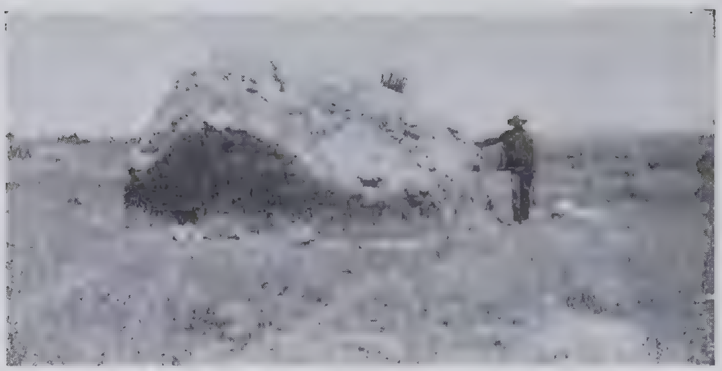

Fig. 11.
Glaciated Quartzite Boulder "White Horse," Irwin River.

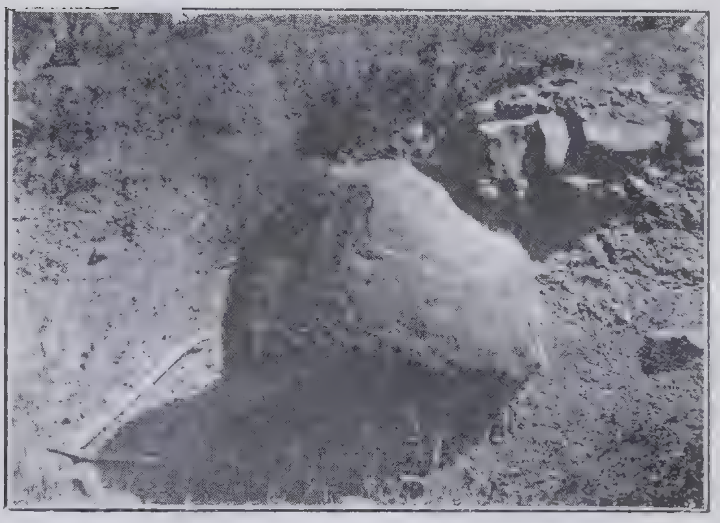

Fig. 12.
Glaciated Granite Boulder embedded in Blue Clay, Irwin River.

boulder, of which the portion visible above the ground measures 7 feet high, 18 feet long and 13 feet wide, locally known as the "White Horse" (Fig. 11, Plate IX). Another conspicuous granite boulder embedded in a calcareous blue clay occurs in close proximity (Fig. 12, Plate IX). Mr. Campbell also noticed below the coal seams in the south branch of the Irwin River clays and shales containing granite boulders at an altitude of about 890 feet above sea level (Fig. 13, Plate X). On the summit of the Brockman Hills, at 862 feet above sea level, Mr. Campbell detected a glaciated boulder of quartzite, whilst on a low rise 683 feet in height, about two miles to the south-east, were many other fine ice-scratched blocks. According to Mr. Campbell's observations, all the boulders are of local origin, and :—

> "the boulder beds probably represent terminal moraines of the glaciers which at that period evidently descended from the plateau into the sea, and the blue clays represent the subaqueous deposit of glacial mud or till."

The section (Fig. 14, Plate VIII) showing the stratigraphical position of the boulder bed, prepared by Mr. Campbell, clearly indicates that this horizon is interbedded with marine strata and it is more than likely that the boulder bed itself is of marine origin, like that in the Gascoyne watershed. Mr. Campbell fixes the Irwin River horizon as being the equivalent of that of the Permo-Carboniferous Greta Series of New South Wales. From the fossil remains above this glacial horizon Mr. Etheridge inclines to the opinion that the Irwin River beds are rather that of the Carboniferous than the higher Permo-Carboniferous.

The following is the list of fossils from these beds :— *Nubecularia lucifuga*, var. *Stephensi*, Howchin ; *Pleurophyllum Australe*, Hinde ; *Productus semireticulatus*, Martin ; *Productus subquadratus*, Morris ; *Productus tenuistriatus*, var. *Foordi*, Eth. fil. ; *Productus undatus*, Defrance ; *Seminula subtilita*, Hall ; *Reticularia lineata*, Martin ; *Chonetes Pratti*, Dav. ; *Dielasma*, sp. ; *Fenestella fossula*, Lonsdale ; *Aviculopecten Sprenti*, Johnston ; *Conocardium*, sp. ; *Stutchburia*, cf. S. (*Pleurophorous*) *Randsii*, Eth. fil. ; *Bellerophon costatus*, J. de C. Sby., var. ; *Gastrioceras Jacksoni*, sp. nov.

Although Mr. Campbell mentions erratic blocks as occurring on the range to the east of the area occupied by the Irwin River Series, he does not record the presence of any undoubted glaciated pavements.

THE NORTHWARD EXTENSION OF THE LYONS CONGLOMERATE.

There is in the Kimberley district (lat. 16°-17° S.) a large development of fossiliferous Permo-Carboniferous rocks, which are divisible into a lower or limestone series and an upper or sandstone series. So far as observations in the Kimberley rocks have yet been carried, no boulder beds showing ice action have been recognised, though in view of the occurrence of Permo-Carboniferous glacial conglomerates in India, within 17 degrees of the equator, their presence in the farthest north of Western Australia would cause me little surprise.

CORRELATION OF THE DEPOSITS.

With regard to the geological horizon of the "Lyons Conglomerate," there are very sound geological reasons for believing it to have been contemporaneous in age with those beds which afford evidence of the glaciation that affected India, South Africa, South America, and Eastern Australia in Permo-Carboniferous times. In the four continents in which the evidences of this refrigeration occurs it is noteworthy and of importance that the glacial conglomerates are succeeded by coal seams, and beds containing the cold climate plants of the *Glossopteris* and *Gangamopteris* flora. There seem to have been inter-glacial stages in all four continents during the Permo-Carboniferous period, but so far there is no clear evidence of any such in Western Australia. This Permo-Carboniferous epoch presents, perhaps, one of the most remarkable problems disclosed by geology.

In India the glacial boulder beds have been found at several localities in Talchir and the Salt Range at places 700 to 800 miles apart. In South Africa all the observations indicate that the area occupied by the Dwyka glacial conglomerate has a horizontal extent of 800 miles. Whilst in most of the States of the Australian Commonwealth glacial beds of this age occur with a range between 23° and 43° south latitude, and about 35° of longitude; in Eastern Australia, however, these glacial deposits do not appear to have been quite synchronous in all localities.

The geological horizon of the "Talchir Conglomerate" in India, which is characterised by a boulder bed with a silt-like matrix, appears to correspond approximately with the basal member of the Upper Carboniferous Series. What is known as the Productus Limestone Series, which in the Salt Range overlies the Talchir Boulder Bed, affords good grounds for correlation with the beds on the Gascoyne, the Minilya and the Lyndon Rivers.

According to recent researches into the palaeontology of the Salt Range beds of India, it appears that *Spiriferina lata*, McCoy, of Western Australia, is hardly to be dis-

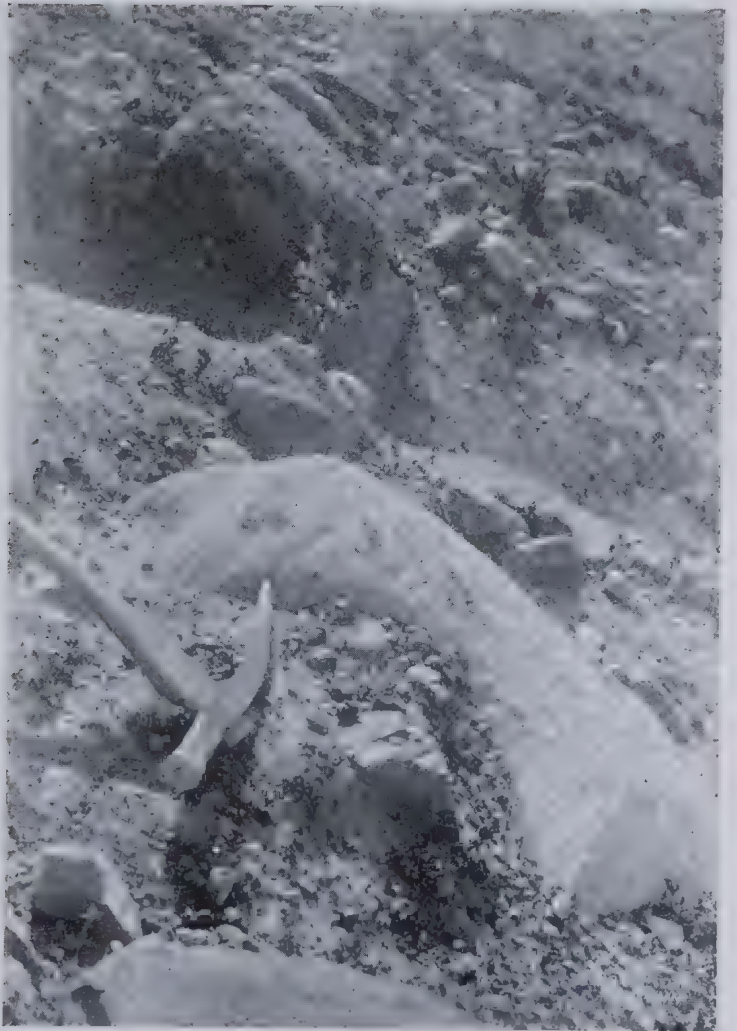

Fig. 13.

Ice-scratched Granite Boulders embedded in Blue Clay, Irwin River.

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tinguished from *Spiriferina infer*, Waag, occurring in the Lower Productus Limestone. *Spirifera Hardmani* is merely a variety of *Spirifera Marcoui* occurring at Amb.; *Athyris Macleayana* is identical with *Athyris capillata*; *Aulosteges Baracoodensis* likewise can hardly be distinguished from *Aulosteges Medlicottianus*, *Productus tenuistriatus*, var. *Foordi*, Eth., from the group *Productus tumidus*. The Icthyclorulite *Edestus Davisi*, from the Arthur River, which, from its striking resemblance, has been placed by Karpinski amongst the *Helicoprion*, is of importance for purposes of classification inasmuch as it also occurs in the Permo-Carboniferous (Artinski) Series of Krasnoufinisk in the Government of Perm, in Russia; also in the Salt Range beds, as well as in the Permian Rocks of Japan. The fossils from the Irwin River beds also show an intimate relationship with those of the Productus Limestone of the Salt Range, viz.: *Productus subquadratus* belongs to the series of *Productus Abichi*; *Productus undatus* is like *Productus opunta*, and *Productus tenuistriatus* resembles *Productus tumidus*.

More detailed palaeontological research may, of course, reveal further connecting links, but so far as the evidence at present goes it seems quite clear that the strata containing the glacial boulder beds of India are not only homotaxial with those of Western Australia, but appear to have been deposited in the same great marine area with more or less free communication.

With regard to the precise geological horizon of the Western Australian glacial beds, it appears that the facies of the Gascoyne fossils, a list of which has been previously given, according to Mr. Etheridge, who acts as our Hon. Consulting Palaeontologist:—

> "is purely carboniferous."

Should this interpretation be correct, it is quite clear that the beds associated with the Lyons Conglomerate as developed in the Gascoyne and the northward, must be considerably older than that of the glacial horizons in the Permo-Carboniferous of Eastern Australia and India. The organic remains from Mingenew in the Irwin River coalfield, Mr. Etheridge states, that on the whole, their "aspect" is that of the Permo-Carboniferous of New South Wales. The fossils from the Irwin River below the coal seams are on a much lower horizon than those from Minginew; of these Mr. Etheridge states the facies is:—

> "eminently that of the Carboniferous as distinguished from the higher Permo-Carboniferous."

The palaeontological evidence would thus seem to point to there being in the Irwin River valley strata of both a Carboniferous and Permo-Carboniferous Age.

Now it may be noticed that while such typical Carboniferous types, *Productus semireticulatus*, *Orthotetes crenistria*, and *Aulosteges* occur in the Gascoyne beds associated with the Lyons Glacial Conglomerate, forms like *Strophalosia Clarkei*, *Aviculopecten tenuicollis* also occur, and in the Irwin River area the foraminifer *Nubecularia Stephensi*, which is characteristic of the Permo-Carboniferous of New South Wales, occurs in abundance. I am, therefore, after carefully considering the physical and palaeontological evidence, inclined to regard the strata containing the Lyons Glacial Conglomerate as being homotaxial with those of the Permo-Carboniferous of Eastern Australia. If this should ultimately prove to be correct it would seem that what may be called the purely Carboniferous types lingered on in Western Australia after they had become more or less extinct in the eastern margin of the Continent, and had been replaced in part by Permo-Carboniferous forms. The balance of evidence, therefore, seems to point to the glacial horizon in Western Australia being the equivalent of that in India and Eastern Australia and of Permo-Carboniferous Age.

In South Africa is a well-marked glacial horizon, the Dwyka Conglomerate, occurring below beds which contain representatives of the Lower Gondwana Flora (*Glossopteris* and *Gangamopteris*). The ice which produced the Dwyka Conglomerate did not owe its origin to what may be called the Alpine type of glacier, but all the evidence points to the fact that it was:—

> "a broad continuous ice sheet which spread across 600 miles of country east and west and which advanced at least 500 miles polewards from its apparent source."

No undoubted marine deposits are anywhere associated with the Dwyka Conglomerate in South Africa, for the beds were deposited in large lakes, all the fossils found in which indicate freshwater forms. So far as any evidence at present available goes, it would seem that the South African glacial horizon was formed at the same geological period as that in India and Australia.

In South America there are glacial beds which can be correlated with those of South Africa, India and Australia. In Brazil, near Minas, lat. 28½° south, is a glacial boulder bed, the Orleans Conglomerate, lying below the horizon of beds containing *Glossopteris* and *Gangamopteris*. The Orleans Conglomerate lies close to the base of the Permo-Carboniferous Series as developed in that country. Near

San Luis, in the Argentine, similar Glossopteris-bearing strata have been recorded, whilst in the Falkland Islands a series of beds containing Permo-Carboniferous fossils have recently been described. The whole of the southern portion of East Falkland is made up of strata containing *Glossopteris*, and beneath the Glossopteris-bearing beds is a clayey rock containing boulders and blocks of apparently glacial origin. This horizon appears to correspond stratigraphically with the Dwyka Conglomerate of South Africa.

The beds in South America associated with the Lower Gondwana (Glossopteris) Flora, identical with that found in corresponding strata in South Africa, India, and Australia implies, of course, a corresponding identity in climate, and that the land surfaces over which it extended had such a geographical relation as to permit the migration of the flora between all these quarters of the globe.

From this somewhat brief account of the Permo-Carboniferous ice action in India, South Africa, and South America it will be seen that the glacial phenomena of these regions can, on physical and palaeontological grounds, be correlated with those occurring in Western Australia. Further, the Western Australian glaciation forms part of that refrigeration which affected part of the Southern Hemisphere in Permo-Carboniferous times, and marks one of the most important episodes in the geological history of the State.

THE LYONS CONGLOMERATE IN RELATION TO SOME THEORETICAL QUESTIONS.

The climatic conditions under which the Lyons Conglomerate was produced offer a peculiarly fascinating subject for enquiry, and the first question which naturally suggests itself is, What brought about that remarkable refrigeration, the evidences of which are not only manifest in Western Australia and in India, South Africa, South America, but also in Eastern Australia?

The occurrence of glacial conglomerates near the base of the Glossopteris-bearing beds in these widely separated localities in the four continents point conclusively to their resulting from a common cause. The exact explanation of this glaciation is not, however, it seems to me, quite clear.

A migration of the poles has been suggested as a possible cause of this Palaeozoic glaciation, for it is noteworthy that the remains of this glacial period all lie within about 30 degrees of the equator.

If the position of the earth's axis of rotation were shifted to about the middle of the Indian Ocean, or of a Gondwanaland occupying its present position, the north pole would be somewhere in New Mexico, near the boundary of Texas. It may be mentioned in favour of the hypothesis of migration of the poles in Permo-Carboniferous times to the positions indicated, that the movement of the Talchir or Indian ice sheet and that of the Dwyka in South Africa are *away* from the equator (Fig. 15, Plate XI).

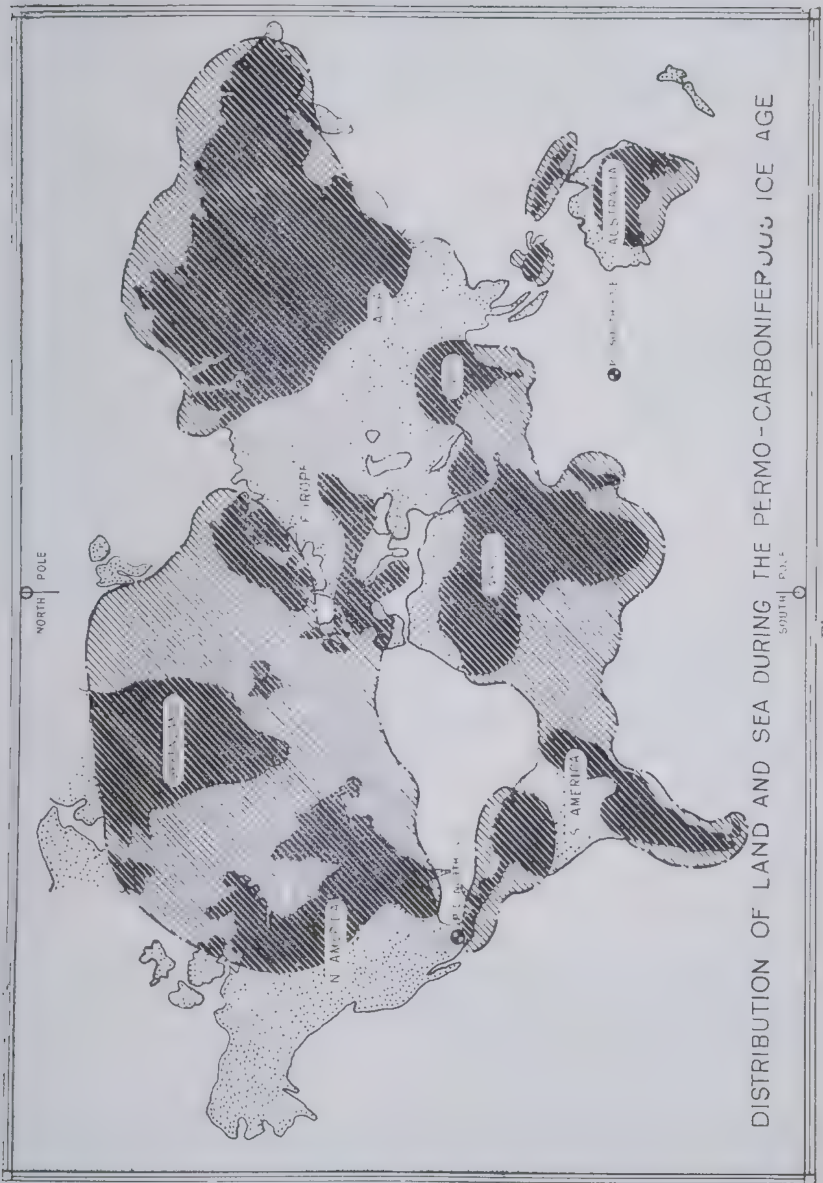
At the same time, if evidence of a Permo-Carboniferous :—

> "warm climate were to be found anywhere in a zone that would be equatorial to an Indian Ocean polar area, or if another Permo-Carboniferous glacial area were to be found in the regions antipodal to the Indian Ocean, this shifting of the poles would have to be very seriously taken into account."

It may in this connection be interesting to recall the fact that a conglomerate of Permo-Carboniferous Age, the characteristics of which are of such a nature as to suggest its origin being due to ice action, has recently been described as occurring in Colorado. The remarkable focussing of glacial deposits about the Indian Ocean in Permo-Carboniferous times may in a certain sense be paralleled with that about the North Atlantic Ocean in Pleistocene times. On the other hand astronomers seem all to agree that a migration of the pole as would bring it into such a position in the Indian Ocean as has been indicated (involving, as such would do, a change of about 66°) is an impossibility, at any rate since the birth of the moon, which took place in those "Dark Ages" of the earth's history long prior to Permo-Carboniferous times. The objection, however, to the hypothesis of the migration of the poles is not based upon the results of direct observation, but rather upon mathematical reasoning.

It would make too large a draft upon your time to attempt even a cursory examination as to whether this Permo-Carboniferous glaciation was brought about by local elevation of the land masses through thousands of feet; by the high phase of the eccentricity of the earth's orbit in combination with winter in aphelion; by variations in the amount of aqueous vapour; by the ionization of the atmosphere; by variations in the amount of carbon dioxide in the atmosphere; by the ocean currents resulting from the contemperaneous relations of land and sea; or by a variation in the amount of the sun's heat; as these are somewhat outside the scope of this address.

The exact cause of this Palaeozoic glaciation of Western Australia would seem to me to remain as yet an unsolved problem, though it may be that as the question of past



DISTRIBUTION OF LAND AND SEA DURING THE PERMO-CARBONIFEROUS ICE AGE

Fig. 15.

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geological climates becomes more thoroughly investigated such may be found to result from a combination of several different factors, both general and local.

It has already been pointed out that the Western Australian Permo-Carboniferous beds were deposited in the same great marine area as that containing the corresponding strata of India, and that from the similarity of the organic remains there must have been more or less free communication between the two localities during this geological epoch. This fact has some bearing upon the question of the permanency of ocean basins.

There seems to have been during the period immediately following the ice age, which has just been described, a land connection between India and South Africa, although it would not seem necessary for an explanation of the distribution of the Glossopteris flora that the whole of the Indian Ocean formed part of one uninterrupted continent at one time.

In Cretaceous times there was a land connection between South Africa and India across the Indian Ocean by way of the Maldive and the Mascerene Islands. Even at the present time traces of this barrier can be detected, for the north-west portion of the Indian Ocean appears to be cut off from the main ocean basin by a shallow belt, extending from the Seychelles to the Maldives, which latter are connected by comparatively shallow straits with Madagascar and South Africa, and the Maldives with India, the Seychelles and the Comoro Islands being as it were stepping-stones yet unsubmerged.

So far, therefore, as different lines of enquiry carry us, it is quite clear that the northern portion of the Indian Ocean was bridged by land which connected South Africa and India up to Cretaceous times, and this connection seems to have broken up into islands during the Tertiary period. In other words, what is now a broad and deep ocean was for a long geographical period occupied by land; and the ocean bottom between India and South Africa has sunk to its present depth since the Cretaceous Period.

CONCLUSION.

In bringing to a close what has, I fear, been a more or less dreary recapitulation of ascertained facts, I would just like to recall to your recollection the memorable words of the Astronomer La Place, which in my opinion form a fitting termination to the contribution to the glacial geology of Western Australia, which it has been my privilege to lay before you:—

> "*What we know is but little; what we do not know is immense.*"

THE FEDERAL CAPITAL SITE. BY J. G. HAY.

(Read September 12th, 1911).

A DESCRIPTION OF SOME ARTIFICIAL RE-CONSTRUCTED AND SYNTHETIC GEMS. BY J. H. BOAS, B.Sc.

(Read October 10th, 1911.)

ABSTRACT.

The author first defined the following terms :—

> *Artificial gems* are laboratory products which simulate the appearance of but have not the specific properties of natural gem stones.
>
> *Reconstructed gems* are laboratory products made by fusing broken or imperfected stones into larger and more perfect gems.
>
> *Synthetic gems* are made by chemical processes and have not only the appearance, but also the specific properties of the natural stones.

The main methods of imitating gems were described, including the various forms of doublets, paste gems, and natural stones substituted for more valuable gems. Some types of doublets were exhibited.

A description of those properties most valuable for the exact determination of the nature of gems was then given, together with an account of the Herbert Smith refractometer and the dichroscope. The use of these instruments was demonstrated.

The main portion of the paper dealt with the manufacture of reconstructed and synthetic rubies and emeralds, together with the results of many examinations of the specific properties of these gems. The most recent method for the manufacture of these stones by Verneuil's method of fusing the finely powdered mineral or its equivalent, pure alumina, together with the proper amount of colouring matter, in properly designed oxyhydrogen blowpipes, was described.

Pure alumina fused in this way gives white sapphires. The addition of tiny quantities of chromium oxide yields the ruby. For many years attempts to obtain the blue colour of the sapphire failed because oxide of cobalt was used as the colouring agent. This fails to combine with the alumina unless magnesia is added. The result, however, was the formation of blue spinels, differing entirely in properties from the sapphire. Within recent years the use of oxide of titanium has led to the manufacture of sapphires, but the colour of the stones is not really good, and they can be readily detected from natural sapphires.

The following problem was considered. Reconstructed and synthetic gems have apparently the same properties as those of the natural gems. They are as beautiful and as durable. Is it possible by careful examination of their physical properties to distinguish between these laboratory products and the natural stones?

The author's examination had been delayed for some months until the arrival of a Herbert Smith refractometer, and in the meantime this work had been done by Noel Heaton and his results described before the Royal Society of Arts.

A great number of stones had been examined, and careful examination showed that in the case of rubies the reconstructed and synthetic stones had exactly the same physical properties as those of the natural gems. Chemical analysis also fails to show any difference. The following figures illustrate this :—

	Specific Gravity.	Refractive Index.
Real Rubies...........	3.9–4.1	1.765 ...
Reconstructed Rubies ..	4.00–4.05	1.760–1.770
	extreme readings from 16 measurements.	extremes from 16 measurements
Synthetic Rubies	4–4.1 4 measurements	1.760–1.763 7 measurements

The colour of laboratory stones is very even and generally somewhat paler than that of natural stones: but these latter vary considerably in these respects, and this alone is not a sure method of detection. Noel Heaton has suggested in his paper as the only possible method of distinction the examination of the enclosures, especially gas bubbles, under the microscope. The stones are placed in cells fitted with a highly refracting liquid in order to do away with the difficulty due to reflection from the cut facets. [The author used a suitable mixture of methylene iodide and benzine in his examination.]

In natural stones the gaseous inclusions follow the lines of growth of the crystals and are more or less irregular in shape, whereas in laboratory stones they are spherical.

As a result of the examination of a great number of stones, the author is led to the conclusion that though the method is undoubtedly useful as a rule, yet cases occur in which it is valueless. Specimens were exhibited of synthetic stones apparently free from gaseous inclusions, and one undoubted Siam ruby was shown in which the inclusions were perfectly spherical. This being so, it is doubtful whether the method is of real value in absolutely determining the origin of a stone.

In the author's opinion a reconstructed or synthetic ruby is a ruby. This term means simply a collection of chemical and physical properties all of which are possessed by the laboratory gems. The question was discussed as to whether a court of law would hold it a fraud if such stones were sold as rubies without any qualifications.

Incidentally it was mentioned that there was great difficulty in obtaining good specimens of rubies. Most stones sold in Perth as rubies are really spinels.

In the case of emeralds, there is no difficulty in detecting the artificial stones. These are sold as reconstructed emeralds, but all those examined were made by fusing the proper constituents with oxide of chromium. All attempts at making synthetic gems which contain silica have till the present failed. The results are not crystalline and are easily distinguished on examination with the dichroscope.

The physical properties of the so-called reconstructed emeralds were also examined, and show clear differences from those of the natural stones, as is seen from the following figures :—

	Refractive Index	Specific Gravity
Natural Emerald	1.57–1.58	2.69
Reconstructed Emerald	1.53–1.54	2.96

Finally, the question of the color of the gems was briefly touched on. Heaton suggested in his paper that the colour of the ruby may be due to chromium aluminate in solution, or to metallic chromium in colloidal suspension. The latter idea is most improbable, because the chromium is added as oxide and the action carried out in a strongly oxidising atmosphere.

Chromium oxide is also the colouring agent in the emerald, and the author's idea was that in this case the chromium functions as a base, in the presence of the acidic silica forming chromium silicate. The colour is then due to the presence of chromion. In the ruby the chromium acts as an acid to the basic alumina and forms aluminium chromate, the colour being due to chromanion.

Experiments to test this idea had been carried out, and were still in progress, but no crucial test had yet been found.

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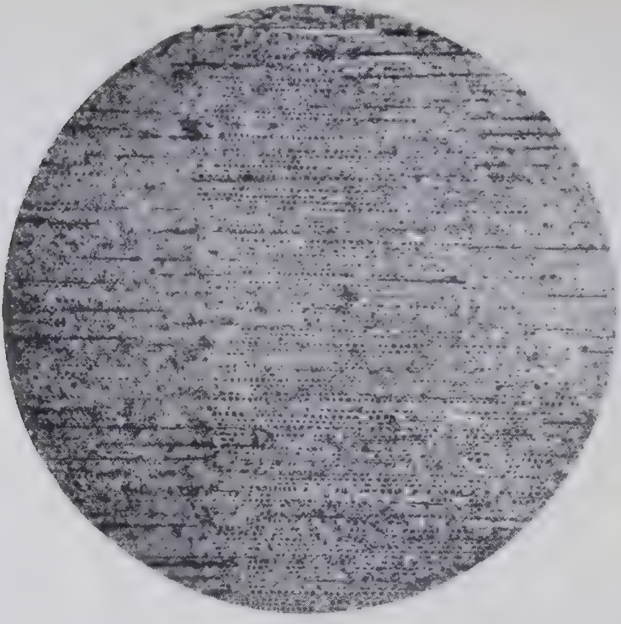

Fig. 16.
Fossil Wood, Dandarragan.
Cross Section X20.
Showing junction of two annual rings.

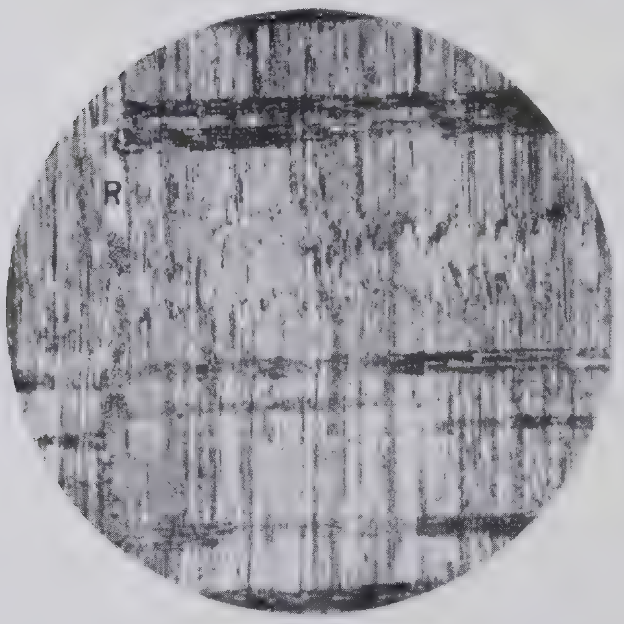

Fig. 17.
Fossil Wood, Dandarragan.
Radial Section X20.
Showing medullary rays, interlocking of tracheids, and resin vein (Rv) between two annual rings.

UNUSUAL TYPES OF PETRIFACTION FROM DANDARRAGAN.

By EDWARD S. SIMPSON, B.E., F.C.S. (Read November 14th, 1911.)

PLATES XII AND XIII.

Recently the present writer has studied the microscopically perfect conversion of fragments of coniferous wood of Mesozoic age into fluor-apatite (fluophosphate of lime) and dufrenite (hydrous phosphate of iron) at Dandarragan. The latter, so far as can be ascertained, has never been recorded as the petrifying agent of plant tissue, whilst the former is apparently of somewhat rare occurrence. These unusual types of petrifaction seemed, therefore, to be worthy of detailed description.

In modern works on Palaeontology but little space is devoted to agents of petrifaction, and none whatever to the chemical processes involved in the molecular replacement of the various organic constituents of plant tissues by mineral substances of more durable nature. Even in F. W. Clarke's "Data of Geochemistry," a work otherwise so complete in its review of this branch of science, this interesting and important geochemical subject is entirely ignored, except for a slight passing reference in connection with the discussion of an entirely different question.

In this paper we are concerned simply with that limited section of the study of petrifaction which deals with the mineralisation in microscopically perfect detail, of the trunks and limbs of plants. Of the many minerals which, by molecular replacement of the tissue of wood, have preserved for us, more or less perfectly, through many geological ages, the original structure of the timber, the most common in Australia are the various varieties of quartz, coal and calcite.

Of plant petrifying agents in the Northern Hemisphere the most complete account available is contained in Solms-Laubach's "Fossil Botany." From this work the following extracts are taken*:—

> "Very various bodies occur in nature as agents of petrification. Among these silicic acid (in the form both of opal and of chalcedony) has the first claim to mention here. . . Silicified woods are found in extraordinary quantities in all formations. . . The next in order of importance are the isomorphous carbonates of calcium, magnesium and iron, $CaCO_3$, $CaCO_3 + MgCO_3$, $FeCO_3$. Goeppert is of opinion that calcium carbonate is present in some petrifictions in the form of aragonite, it occurs in most cases as calcite. . . Petrifactions in carbonate of iron very commonly form the nucleus of clay ironstone nodules. Wood petrified in fluorspar is very rarely found. . . Petrifaction in gypsum is still more rare. . Calcium triphosphate is also

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* Solms-Laubach, H. Graf zu: Einleitung in die Palaeophytologie, Leipzig, 1887.

known as a petrifying agent, roundish lumps of this material containing well preserved and determinable woods are found, according to Vater, in abundance in beds of phosphorite in Brunswick. Portions of the wood of Calamites preserved in this phosphate, according to Stur, are found also in the uppermost beds of the Coal measures. Grand 'Eury reports the presence of similar fossils in the "couche des Rochettes" and the 'couche des Littes.' . . Barytes, pyrites, red and brown iron ore, argentiferous copper glance and argillaceous earth are also said by various authors to be petrifying agents."

Laubach also speaks at length of the well preserved fragments of wood, etc., converted into coal.

Other writers refer to the occasional occurrence of phosphatised wood in conjunction with "coprolite" beds. Thus D.C. Davies† mentions its appearance in the Cretaceous phosphatic deposits of the Ardennes and Meuse stretching across the frontier of France and Belgium, and also in the similar beds of the Russian provinces of Smolensk, Orel, Komsk and Voronife. Prof. R. Zeiller‡ says :—

> "It is not uncommon to find vegetable remains, especially fragments of stems, whose tissue has been completely mineralised by the action undoubtedly of waters feebly charged with silica, carbonate of lime, carbonate of iron, or sometimes even phosphate of lime."

Every authority speaks of the comparative rarity of phosphatised wood, and speaks very indefinitely of the actual mineral species present. It is not certain, therefore, whether previous cases were known of the conversion of wood into genuine fluor-apatite, containing theoretically 7.7 per cent. of calcium fluoride and 92.3 per cent. of calcium phosphate, or whether these cases were instances of conversion into "phosphorite" containing little or no fluorine. The conversion of wood into dufrenite does not seem to have been observed elsewhere.

The phosphatic beds at Dandarragan, from which these specimens came, have been superficially examined by one of our members, Mr. W. D. Campbell, and described by him in Bulletin 26 of the Geological Survey of W.A. They consist of :—

(*a*) An upper bed of pale coloured sandstone carrying numerous concretions of calcium phosphate (coprolites), with a little secondary dufrenite and wavellite, the whole rock averaging 15 to 20 per cent. of P_2O_5.

(*b*) A lower bed of highly ferruginous sandstone, carrying dufrenite, with at itmes a little phosphorite or vivianite. Assays showed 7 to 15 per cent. P_2O_5.

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† Davies, D.C. "Earthy and other Minerals and Mining," p. 154.
‡ Zeiller, R. Eléments de Paléobotanique," p. 9.

Structure of Dandarragan Wood.

In the upper sandstone bed are numerous fragments of white or yellowish fossil wood. In the specimens seen they are usually about three inches in diameter and four to eight inches long. For the most part they present complete sections of the stem with the exception of the bark and possibly sap wood. They are inclined to be slightly soft and powdery on the surface (perhaps this is the sap wood), but are quite hard and solid immediately below. On cross fractures the annual rings are readily discerned by the unaided eye, whilst vertical sections exhibit a fibrous structure, leading to a ready vertical cleavage. In one case the external surface had a conical fluting similar to that on the present day gimlet wood of Western Australia, *Eucalyptus salubris*. All the specimens so far examined appear to belong to the one botancial species, and that a Conifer.

Thin slices show that for the most part the most minute structures have been perfectly preserved. At times, however, in areas with a more or less rounded boundary, the structure is somewhat obscured. In the accompanying Plate XII are seen sections, cross and radial, of a typical specimen.

The average thickness of the annual rings is about two millimetres (0.08 inch), but in a single specimen was seen to vary from slightly less than one millimetre up to 4 mm. The greatest width observed was 5 mm. The tracheids are arranged in radial lines, and are rounded in cross section. They are from 0.3 to 0.05 mm. in diameter with a cell wall averaging 0.1 mm. in thickness. The tracheids have a maximum diameter in the " spring wood " on the inner side of each season's growth, gradually flattening within each ring as one proceeds outwards. The length of two measured sets of tracheids was found to be 4 mm. Their method of interlocking is illustrated in the photos of the radial section. In parts of this same section the characteristic pitting of the inner walls of the tracheids is well preserved. The pittings form for the most part a single row, a single pit, however, is not infrequently replaced by a pair, the pits of which are always opposite, never alternate.

The medullary rays are numerous and are composed of two to twelve rows of cells in a single series. No structural signs of parenchyma or wood vessels were seen. Resin canals are absent, but very rarely between certain annual rings there is a narrow annular space (Plate XII, Fig. 17) which would appear to have been once filled with resin. These show no traces whatever of cell structure. The present filling is apatite, partly colourless, partly brown in colour from admixture possibly with still unaltered resin. Indications of the presence of some such substance were given by the stickiness of the powder in grinding and by the combined carbon shown by analysis.

Zeiller says* :—

> "The study of the woods of Conifers has shown that the general features of their structure only permit of our distinguishing a certain number of large groups, and not of recognising individual genera."

He defines *Cedroxylon* (wood of the Cedar type) in the following terms :—

> "*Cedroxylon* (Kraus). Wood formed, like that of *Cedrus* and *Abies*, of tracheids with radial faces provided with areolated pittings in single rows, and lacking resiniferous elements or at least with resiniferous parenchyma almost absent. This type dates back to the Permian."

The Dandarragan wood is, therefore, provisionally classed as *Cedroxylon*.

COMPOSITION OF THE DANDARRAGAN WOOD.

Dufrenite is a common mineral at Dandarragan in the more ferruginous beds. Owing to its bright green colour it was the first mineral in the district to attract attention. It appears to have been formed *in situ* by the action upon limonite of carbonated waters carrying lime phosphate dissolved out of the adjacent coprolite beds. Three small specimens from these beds which came into the writer's possession appeared to contain fragments of fossil wood completely converted into dufrenite, and embedded in compact ironstone. One of these fragments, measuring 40 x 30 x 20 mm., and exhibiting to the unaided eye the vertical fibres and medullary rays, was sectioned. Under the microscope the cross section shows a structure precisely similar to that of the apatised wood already described. In certain areas this structure was well defined, but in others was entirely obscured by the strongly developed cyrstalline structure of the dufrenite. Certain cracks were filled with moderately large (0.2 mm.) crystals of this mineral.

Typical examples of the apatised and dufrenised wood were analysed with the following results :—

	Apatised Wood.	Duffreinsed Wood.
Silica, SiO_2	1.26	.48
Carbon dioxide, CO_2	1.31	.24
Phosphoric oxide, P_2O_5 ...	38.80	31.26
Water combined, H_2O+ ..	.80	14.07
Lime, CaO	53.88	.64

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* Loc. cit., p. 279.

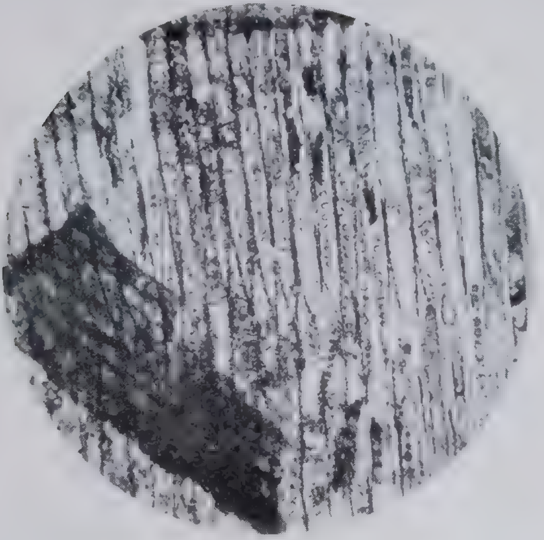

Fig. 18.
Fossil Wood, Dandarragan.
Radial Section X70.
Showing pitting of tracheids.

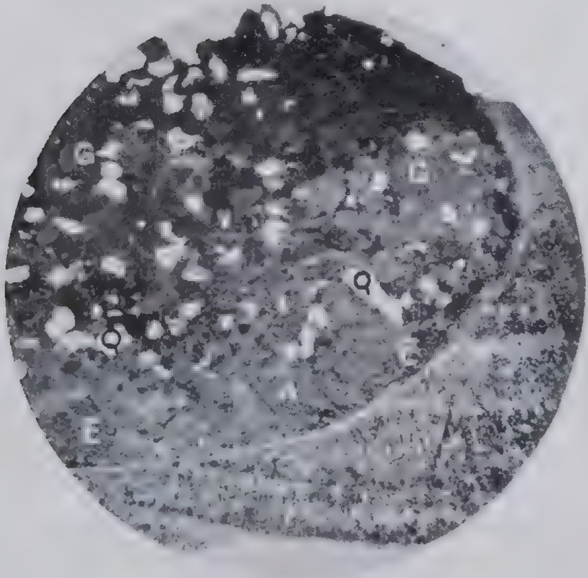

Fig. 19.
Fossil Wood, Dandarragan.
Cross Section X20.
Showing section of gallery made by boring organism, and now filled with granular phosphate (A), quartz (Q), glauuconite (G), and fossil excreta? (E).

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Magnesia, MgO	1.17	none
Manganese oxide, MnO	.78	.20
Iron protoxide, FeO	none	8.34
Iron peroxide, Fe_2O_3	1.01	40.15
Alumina, Al_2O_3	min. trace	4.44
Chlorine, Cl	.01	none
Fluorine, F	3.00*	none
Carbon, C (in organic combination)	.18	.40
Water hygroscopic, H_2O	.22	.32
	102.42	100.54
Less oxygen=fluorine	1.26	
	101.16	

I am indebted largely to Mr. H. Bowley for these results.

The deposits in which these fossil woods are imbedded were probably laid down in an ocean, since glauconite, a silicate of iron and potash, characteristic of oceanic deposits formed at no very great distance from land, is freely associated with them. At first sight it is difficult to account for the presence of a light coniferous wood in such a situation. It is not uncommon, however, for barnacles at the present day to so increase in numbers on a floating piece of pine as to sink it permanently, and in some such way the fragments of *Cedroxylon* found their way to the bottom of the Mesozoic Sea. The means by which they were preserved from bacterial destruction, and the details of the processes involved in the molecular replacement of cellulose and lignin by calcium and iron phosphates, still remain to be worked out.

That timber even in those remote days was subject to the destructive attacks of boring organisms is evident from the numerous tunnels of such creatures in almost every specimen of this wood. These holes range in diameter from 2 to 15 mm. and are filled with a mixture of granular lime phosphate, grains of quartz and of glauconite. A section of one is seen in Fig. 19, Plate XIII. Embedded in this filling are clusters of spherical brown bodies ranging in diameter from 0.02 to 0.10 mm. Similar bodies are considered by Seward† to be the fossil excreta of wood boring beetles, etc. Apart from this suggestion we have no evidence as to whether the boring was done by land insects before the wood reached the water, or by marine organisms, such as *Teredo*, after drifting out to sea.

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* From weight of CaF_2, 2.97 and 3.05; from $CaSO_4$, 2.94 and 3.06.

† Seward, A. C.: Fossil Plants, Vol. I, p. 107.

THE CAUSES OF THE FERTILITY OF THE WESTERN AUSTRALIAN SEMI-ARID WHEAT LANDS. BY G. A. PFISTER.

(Read December 12th, 1911.)

When I first came to this State I not only gathered information on the agricultural practices of this country but actually worked as a farm-hand for two years, so as to study the conditions on the spot, and one of the facts that astonished me most was the small amount of manures given to the wheat crops as compared to the fertilizers given to similar crops in other parts of the world, and the comparatively heavy crops harvested after such scanty manuring, which at first sight seem altogether out of proportion to the manure supplied.

During the last five years I have made a good number of experiments, having had under control over 250 cereal plots in different parts of the State. Some friends of mine, earnest reliable farmers, also have rendered invaluable service by carrying out a good number of experiments in plots and in fields, and by supplying numerous data and records which have greatly helped me.

Taking a fair average of these experiments, I have come to the following conclusions :—

(1) Our West Australian wheat soils are generally deficient in lime on the surface.
(2) The quantity of manures usually supplied with the seed to these lands varies from 70 to 100 lbs. of superphosphate of lime.
(3) The eventual increase of crops due to larger amounts of superphosphate is so small as not to justify the increase in expenditure.
(4) Nitrogenous and potassic manures if given together with superphosphate and contempeareously with the seed, do not give sufficient returns to pay for the increase in the cost of manuring. This is altogether in contradiction with the results obtained in Europe and America.
(5) Crops grown on fallowed land are much heavier than those grown on land which has not been fallowed. Such splendid results as 25 to 40 bushels and more per acre have been obtained on fallow land with 90 lb. superphosphate and 13-inch rainfall.

From this we learn :—

(1) That it is not advisable to manure heavier than 1 cwt. of superphosphate per acre.
(2) That it is advisable to fallow our lands.

These are deductions which most farmers know to be correct from their own experience. Still, they do not explain anything: they only state the facts.

Let us first examine the figures dealing with the principal materials which a crop contains.

A crop of 15 bushels and weighing 2,500 lb. or about 2 tons of grain and straw has removed from the soil during the period of growth—

24 lb. Nitrogen;
10½ lb. Phosphoric Acid; and
14½ lb. Potash.

If we compare these figures with the amount of nitrogen, phosphoric acid and potash which a great number of analyses of wheat soils made by myself and others reveal, it would seem as if it was quite unnecessary to manure at all, because:

24 lb. nitrogen, compared with the average weight of a 6-inch layer of soil on 1 acre surface = about 0.0015%;
10½ lb. phosphoric acid, compared with the average weight of a 6-inch layer of soil on 1 acre surface = about 0.006%; and
14½ lb. potash, compared with the average weight of a 6-inch layer of soil on 1 acre surface = about 0.001%.

While the wheat soils show an average content of—
Nitrogen = 0.085% (maximum 0.1);
Phosphoric acid = 0.0068% (maximum 0.01);
Potash = 0.016% (maximum 0.02).

The trouble, however, is that wheat-plants (as other green plants) can only absorb raw material from the earth in solution, and that, unfortunately, the above quantities are not all found in water or citric acid soluble form.

Therefore, they are not all available to the plants, and the plant must look elsewhere for part of its supplies.

As you see, wheat is above all a nitrogen-feeder. Now, I found (and others found the same) that the addition of nitrogenous and potassic manures in Western Australian wheat lands does not pay. Some experiments made in these regions gave the following results:—

Field.	Manure.	1908.	1909.	1910.	1911.
		Bushels	Bushels	Bushels	Bushels
1	No manure	6	6½	7⅓	Failure
2	90 lb. Superphosphate...	14	15½	1 ½	,,
3	90 lb. Superphosphate, 28 lb. Sulphate of Ammonia, and 28 lb. Sulph. of Potash	12⅔	14¾	18½	,,

These results may well be compared with the results obtained at Wagga (N.S.W.) by Mr. Helms :—

Plot.	Manuring.	1900.	1901.	1903.	1904.
1	No Manure	7⅔	17⅔	20⅔	11
3	Superphosphate only	13⅓	22⅔	33	14¼
8	Superphosphate, Sulphate of Ammonia, Sulphate of Potash	10	20⅓	32⅓	15⅓

As I mentioned before, these results are in open contradiction to those obtained with similar manuring in Europe and America. Any text-book dealing with agriculture in these countries will show this to be true.

In attempting to explain this, I think that in the first place it is the climate to which we must look for an explanation.

In Europe and America, the wheat is sown in autumn and the young plants after making but little progress are covered with snow during the winter months. Of course, during this period they make no growth. Spring comes, the snow thaws, and only those who have witnessed such thawing know what a heavy leaching of the soil it means. In countries where the climate is milder, and little or no snow falls during the winter months, the very heavy rains leach the ground just as much as thawing snow. The wheat then begins to grow in spring and grows during April, May and June. Now in these months most of the European and American wheat district show a rainfall of about 15 to 20 inches, *i.e.*, more than our wheat lands get during a whole year. This means further leaching. In July the grain ripens; that means, no growth takes place, the saps in the plant diminish and the absorption of fresh plant food from the soil is very insignificant, while chemical changes take place within the plants which bring about the ripening of the grain.

Having proceeded so far in my subject, I must stop for a moment and say a few words on nitrification in soils. A great deal has been said and written on this subject, so that I really must crave your pardon if I once more come to speak of it, as there might be some amongst you who are not quite conversant with this important phenomenon.

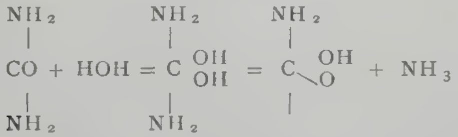
Let us remember that "bacteria," "baccilli," "micrococci," "micro-organisms," "microbes," or "microphytes," are all names which are given to minute vegetable organisms consisting of one single cell, which has no ordinary nucleus and contains no chlorophyll. They are also characterized by the absence of ordinary sequal reproduction. Now, baccillus or bacterium are unsatisfactory terms, as really they have narrow technical meanings. The proper name for this class of organisms is Schizomycetes, a term to which I shall keep in this lecture unless I speak of that particular kind of schizomycetes which are called bacteria. The size of these organisms is usually 1 μ (.001 millimeter) in diameter, and 1 5 μ (.001 to .005 millimeter) in length. Therefore it is not to be wondered at that up to 400 million have been found in one grain of cultivated soil.

The important discoveries of Fischer, Koch, Pasteur, Winogradsky, Hilfner and Stormer, and many others, have shown that these schizomycetes play a great part in the fixation of nitrogen in soils, and their work is of special importance to us in Western Australia.

We know now that in all cultivated soils there are forms of schizomycetes, mostly bacteria, which are capable of forcing the inert free nitrogen to combine with other elements into compounds assimilable by plants. Winogradsky showed that one of these, Clostridium Pasteurianum, is enveloped by aerobic bacteria or by fungi living in symbiosis, which prevent the access of free oxygen; and if the conditions of growth are favorable, *i.e.*, if carbohydrates, potassium hydrogen phosphate, magnesium sulphate, sodium chloride, ferrous sulphate and manganese sulphate are present, Clostridium will fix nitrogen in proportion to the amount of sugar consumed.

As a typical example of the many cases of nitrification which go on in soils, the decomposition of Urea $[CO(NH_2)]$ will serve well.

Urea at first becomes carbonate of ammonia $(NH_2)_2 CO_3$ by a simple hydrolysis brought about by bacteria. This process may be explained as follows:—



$$\begin{array}{c} NH_2 \\ | \\ CO \\ | \\ NH_2 \end{array} + HOH = \begin{array}{c} NH_2 \\ | \\ C \begin{matrix} OH \\ OH \end{matrix} \\ | \\ NH_2 \end{array} = \begin{array}{c} NH_2 \\ | \\ C \begin{matrix} OH \\ \searrow O \end{matrix} \\ | \\ \end{array} + NH_3$$

$$[CO_2(NH_3) + NH_3] + H_2O = CO_3(NH_4)_2$$

The carbonate of ammonia in its turn undergoes nitrification in two stages owing to the activity of the so-called nitrifying bacteria. Let me say at once that the term nitrification is rather unfortunate, as nitrification is only a particular phase of a cycle of changes undergone by nitrogen in the process with which we have to deal.

In fact, in the first place one kind of bacteria, which Winogradsky called nitroso-bacteria, bring about the change of ammonia to *nitrous* acid forming *nitrites*.

$$\overset{\text{Ammonia.}}{2NH^3} + \overset{\text{Oxygen.}}{3O_2} = \overset{\text{Nitrous Acid.}}{2NHO_2} + \overset{\text{Water.}}{2N^2O} \text{ (oxidation).}$$

Then a totally different form of bacteria step in, the nitro-bacteria. In fact, these are incapable of utilizing carbonate of ammonia; but after this has been changed into nitrites by the nitroso bacteria, they oxidise these nitrites still further. Nitrous acid becomes nitric acid and thus nitrates are formed.

$$HNO^2 + O = HNO^3.$$

I take the opportunity to mention a most extraordinary fact which Winogradsky discovered while experimenting with nitroso bacteria. He proved that these can change ammonium carbonate into nitrous acid, in the dark, in a solution to which only purely mineral salts (carbonates, sulphates and chlorides of ammonium, sodium and magnesium) had been added. In other words, these bacteria can build up organic matter from purely inorganic matter, by assimilating carbon from carbon dioxide and by obtaining their nitrogen from ammonia.

We have a further important factor in the numerous and much-talked-about bacteria which we find in the well-known nodules on the roots of leguminous plants Their presence enables the leguminous plants to absorb the free nitrogen from the air, and experiments have shown that after culitvation with clovers, lupines, peas, vetches, etc., the soil contains much more nitrogen than before. Allow me to describe a simple but convincing experiment which I have made.

White sand was sterilized by heating it to 150°C. for two hours. Three pots were filled with this soil and lupines were planted in each pot. After the seed had well germinated some soil from a market garden (loam from Cannington) was shaken up in water and this was filtered through cotton-wool. Part of this water was at once added to one of the pots, No. 2; the rest of the water was boiled, cooled rapidly and then added to the third pot. The lupines in the 1st and 3rd pot after forty days showed no nodules and were very weak, stunted plants, while the second pot showed beautifully strong plants on the roots of which we found splendid nodules contaniing thousands of millions of bacteria and bacteroids from which pure cultures were made. Clearly this was a case of infection from the Cannington soil, and chemical analysis showed that nitrogen had been fixed in the soil which could only have been assimilated from the air.

Now, the relation of this schizomycete, called bacterium radicicola, to the leguminous plant, is an exceedingly interesting one. In the beginning the bacterium is free in the soil. When it comes in contact with a root-hair of a leguminous plant it penetrates the cell-wall of the root-hair, which, as you know, consists of a single cell, and multiplies rapidly. A colony is thus formed which then sends out a tube filled with bacteria—the so-called infection thread—which finally pushes its way through the cell-walls of the tissues of the root, causing hypertrophy of the cells and the formation of a bacteroid tissue.

It has not been settled yet whether the bacteria give rise to the infection thread or whether it is the plant which does this. Fischer has justly pointed out that the structure of this tube could be formed only from the protoplasm of higher plants; in other words, that the walls of this tube consist of a substance allied to cellulose, which is not formed by bacteria. Be that as it may, the following facts remain:

(*a*) The bacteria enter the root in the first place as parasites. If they are weak, the plant resists the attack, no nodules are formed, and the colonies die out. If the plant is weak, then the formation of the nodules is quicker and more numerous than in a strong plant.

(*b*) The plant then makes a counter-attack (if strong enough) and becomes parasitic on the bacteria, abstracting nitrogen from them.

The relation between bacteria and plant is clearly not of symbiotic nature, but one of alternate parasitism.

I am afraid you will think that I have quite abandoned my original subject and am lecturing on bacteria. But I had to speak at some length on these organisms because I wanted to give you an insight into the fundamental principles of the work performed by nitrifying bacteria in soils. The knowledge of the few facts that I told you I consider the irreducible minimum necessary to understand the fertility of our wheat lands correctly.

Our soils are, especially in the wheat lands, exceedingly rich in bacteria, both in number and variety. Our wild flowers partly belong to the family of the leguminosae and their roots show numerous nodules caused by bacteria. And now I can come back to my original theme.

The researches made at Rothamstad have shown that in Europe nitrification is most active from July to October, *i.e.*, while the wheat plant is ripening, and therefore assimilates but little food from the soil, and after it has been harvested. The same fact has been proved by a number of Agricultural Experimental Stations in North America.

Little or no nitrification is going on during winter and during the three months preceding the ripening and harvest, *i.e.*, during the period of the plants' strongest growth. The cause of this is to be sought in the temperature and moisture conditions of the soil. In Europe and America, therefore, the nitrates which have accumulated in the late summer and autumn are washed so far down by the heavy winter rains, the thawing snow and the succeeding spring rains, that they are out of reach of the roots of the wheat plants. Hence the costly manuring with nitrogenous manures is a necessity, for we must not forget that wheat is essentially a nitrogen feeder.

In our climate, or rather in our wheat areas, the matter is different. In the first place, in these regions the wheat plant, from the moment of its germination to harvest-time, practically never stops growing; there is no long winter period during which the plant is dormant. Therefore it can avail itself of all the nitrates which have been stored up by the soil-bacteria, before they are washed down into deeper layers. But our rainfall is scanty and not sufficient to leach the soil of its nitrates; furthermore, the temperature and moisture conditions of our wheat-belt are such as to fully justify the supposition that here the nitrification process sets in much earlier than in Europe and America, so that not only the plants find the nitrate supplies from the preceding summer available, but also can make use of the nitrates which are produced during the period of strongest growth of the plant.

You can now clearly see the reason why in Western Australia manuring with nitrogenous manures does not pay and is not necessary, while in Europe and America it is a costly necessity. Indeed, we can pride ourselves and consider ourselves highly fortunate that this is so, and that Nature has bestowed upon our wheat districts one of its greatest riches—nitrogen.

The manuring with superphosphate has its great advantages, inasmuch as it is readily available and gives the young plants a quick start, so that they can sooner avail themselves of the nitrates in the soil.

But the superphosphate plays yet another role. In fact of inorganic substances calcium and phosphorus are absolutely essential to the furtherance of the nitrogen fixation by bacteria. Now our wheat soils are very deficient in lime, and a light manuring with superphosphate of lime certainly helps the bacteria in their work, while if the amount of superphosphate given is increased there is too much free acid, and the bacteria will be hindered in their development and work. I have made several experiments in this direction, and found that the amoun tof bacteria in soils increases when a small quantity of superphosphate is given to it, but will decrease if the dose of superphosphate is increased.

This explains why a heavy manuring with superphosphates does not pay in our wheat lands, while a light manuring, say up to one cwt. per acre, gives certainly satisfactory results, as then this phosphatic manure acts in two ways: first, as a direct fertilizer; second, as a stimulant on the action of soil bacteria.

For probably a somewhat similar reason I have found that superphosphate is not a good manure in the sands of our coastal districts; and that blood-manure is far better. Apart from the percolation, which is very great in sand and allows the superphosphate to be leached out of the sand much quicker than the blood manure, which is not so readily dissolved, there is the fact that blood manure is very rich indeed in bacteria and therefore inoculates the sands, which in their natural state carry a comparatively very poor flora of bacteria. Superphosphates, needless to say, contain no bacteria.

There remain a few words to be said as to the influence of the potassic manures (sulphate of potash) on the growth of the wheat plants in our dry eastern districts.

While there is no doubt as to the increase of the cereal crops due to manuring with potash in other countries, there is no evidence to show that this is so in our wheat lands; on the contrary, experiments have so far given negative results.

Prof. Lowrie, when in this State, told me that he was very much astonished at this result, and personally repeated experiments have convinced me that if sulphate of potash is given together with superphosphate and the seed no advantage results.

I am not prepared to make a definite statement yet as to why this should be so. My experiments so far have been limited to plants in pots and field experiments, which through the kindness of some friends will be carried out next season and will have to confirm the result before it may be regarded as correct. So far I find that if sulphate of potash is given to the soil about three to four weeks before the wheat is sown, a marked increase in the crop results. If it is given together with the seed, and in the drill, then the germination is invariably bad, and a small crop the result. This points to the fact that perhaps the sulphate of potash remaining in immediate contact with the seed for a prolonged period and in a hot and dry seed bed, as it does in our wheat areas, in some way injures the embryo or later on the first rooted of the germinating seed. But, as I said, my experiments are as yet far from being complete, and I do not want to formulate any hasty conclusions which later on may prove to be wrong.

The fact that fallowing increases the yield of our crops considerably is well established. Fallowing is one of the best means of conserving moisture in the soil, as evaporation and capillarity in the top-layer of the soil are lessened. It also aerates the soil, and by doing so not only furthers chemical changes by which the plants are benefited, but also stimulates the growth and activity of the nitrifying bacteria so that a larger amount of nitrogen will be stored up for the next season.

There is, however, another way in which fallowing helps to increase the fertility of our soils. Fallowing prevents denitrification to a great extent. We apply the term denitrification to the reduction of nitrates to nitrites, ammonia or gaseous nitrogen, which is brought about by the action of de nitrifying bacteria under certain conditions. De-nitrifying bacteria are widely distributed. They normally require oxygen, which they mostly obtain from the air. If, however, they are deprived of oxygen in the form of air, or if the oxygen supply is not sufficient, then they will obtain it by breaking up organic matter at the expense of the nitrate, *i.e.*, they will by assimilating the oxygen from the nitrates reduce these to nitrites, ammonia or gaseous nitrogen, with the result that the nitrogen in these forms will be lost to the plants for which we desire it.

By fallowing we loosen and aerate the soil, providing an abundant supply of air (and consequently oxygen) for these de-nitrifying bacteria. These will then not have to break up the nitrates to procure the oxygen, which they normally require. As you see, by fallowing we help nitrification, and we prevent to a large extent de nitrification.

Fallowing is therefore not only an advisable but an absolutely necessary operation where intense cultivation and rotation of crops are not the practice, and for climatic reasons in our W.A. wheat areas it is likely to prove of comparatively higher value than elsewhere.

A Triumph of Mendelism in Wheat Breeding. Professor Biffin's Work at Cambridge University. By W. Catton Grasby, F.L.S. (Read March 12th, 1912.)

ABSTRACT.

(Printed in full in the *West Australian*, June 10th, 1912.)

When our secretary called and asked me if I would read a short paper this evening, I happened to have before me the Report of the Incorporated National Association of British and Irish Millers on the returns received from twenty-nine growers in various parts of the United Kingdom and Ireland, giving the harvest results, the weight per bushel, and the candid opinion of growers on the new wheat, Burgoyne's Fife, raised by Professor Biffin at the Agricultural Department of the Cambridge University. Our society has devoted some attention to Mendelism, and it occurred to me that a few notes on this demonstration of the practical or utilitarian value of the application of Mendel's laws to a subject of national importance to Western Australia could not fail to be of interest.

Another consideration was that this seemed an opportunity for illustrating the practical application of Mendel's laws. At the present time most people confuse Mendelism with the experiments in crossing round and wrinkled, and tall and short peas, or at most with the results obtained by cross-breeding Albino and waltzing mice, or may be certain peculiar breeds of fancy rabbits. It is perhaps quite natural that these oft-repeated and described examples of Mendel's laws should thus have led people to look upon Mendelism as a scientific hobby.

It must be remembered that the most noted of breeders of animals and plants whose names are familiar to all, to a greater or lesser extent used without knowing it the principles which Mendel proved to be natural law. This was the case with the late Mr. Farrer, who must be recognised as the greatest wheat breeder up to the present time. Without the advantage of a knowledge of any fixed laws on the subject, Farrer set himself the task of breeding wheats which would be suited to Australian conditions, be disease resistant and would combine the various recognised valuable qualities of the most useful wheats of the world. He was laughed at and considered a crank and for years received little encouragement except from fellow dreamers. How keenly he felt this I know from the correspondence I had with him in the early nineties, but to-day his wheats, especially Federation, are more widely grown than any others all over Australia. Had he been spared, I have not the slightest doubt but that he would have given us a wheat as strong as Comeback and as hardy and prolific as Federation. Farrer without Mendel's laws did wonders; with them his work would have been shortened and in his experienced hands the results would have been marvellous. It is but just, and no more than Professor Biffin would wish, that in speaking of the results of the Cambridge work I should pay this tribute to Mr. Farrer.

English farmers produce the highest average yields of wheat of the world. English wheats are of very low quality from a miller's and baker's point of view. In 1901 the Home-grown Wheat Committee was appointed by the National Association of British and Irish Millers, with the object of investigating the question whether the quality of English wheat could not be raised without loss of productiveness. The results of their work are important and interesting, but cannot be even outlined here.

In 1902 Professor Biffin began to make a long series of crosses with the object of obtaining in new varieties of wheat a combination of fine quality and great yield of grain and straw. In the *Journal of Agricultural Science* for December, 1908, he contributed a paper on the "Inheritance of Strength in Wheat," in which he said:—

> "Certain varieties of wheat retain their strength under our (English) conditions. One of the best known of these is Red Fife, the grain of which forms the basis of the graded wheat known as Manitoba Hard. Red Fife has now been tested in this country for six seasons and its strength is still found to be equal to that of the same variety grown in Canada."

He explained that as a rule it is not profitable to grow Red Fife because it does not yield as well as the English varieties. It is also weak in the straw as compared with English sorts. He then stated that:—

> "The attempt has been made to build up a variety possessing the high cropping capacity of the common English wheats and the strength of such a variety as the Red Fife To make any definite progress with this work information as to the mode of inheritance of strength was essential."

Unfortunately, strength and weakness do not form a pair of sharply differentiated characters and at times it is difficult to say from a simple inspection of the grain whether it is strong or weak. The only absolute test is to turn the wheat into flour and test it in baking. The common rough-and-ready tests are to bite the grain or, better still, to chew a few grains and note the amount and character of the gluten. It should be here noted that strength is defined as the:—

> "capacity for making large well piled loaves."

In cross-breeding strong with weak varieties it was found that in the F 2 generation it was not difficult to pick out those which had inherited the quality of strength. In crossing strong red on weak white the four groups—strong red, strong white, weak red, weak white—appeared in a reasonably near approach to the 9 : 3 : 3 : 1 ratio required in accord with Mendel's law. He gave evidence to show that by working on Mendelian lines fixed varieties could be secured in the F 2 generation.

Towards the close of his paper he mentioned the work of Mr. Farrer, of New South Wales, in using the Indian Fife as a parent and securing crossbreds with all the strength of the Fife. The most noteworthy of these is Comeback which even when grown in England retains its quality of strength. He then says :—

> "These results . . . show that the problem of breeding strong wheats suitable for English conditions should offer no special difficulties. The question has, however, been repeatedly raised as to whether it is possible to grow sufficiently large crops per acre of such wheats the assumption being freely made that the capacity to yield large crops is associated with the production of starchy grain."

He concluded his paper by expressing the opinion that high yielding capacity and strength could be obtained in the same variety.

It is perhaps desirable to recall the fact that in crossing two varieties of plants or animals no new character can be introduced. New characters come by mutations. All that crossing can do is to bring about a redistribution of character already present in one or other of the parents. Sometimes characters may have been hidden for generations so that their presence is not suspected until the segregation produced by the cross enables them to reappear.

The Mendelian breeder knows this to be law and his work is to determine the characters and combine them for his purpose. Farrer did it by long and patient labour, aided by intuitive insight and experience. Professor Biffin does it by mapping out beforehand what he wants and planning where he is to get it, and then works out his problem by the application of known laws. That is what Mendelism is doing. Much has yet to be learned because the characters in a type of wheat are very complicated. Thus in the straw we have such characters as long, short, strong, weak, solid, hollow, white, dark, and so forth. In the ear we have great variation in shape, from the club to the long tapering ear, tight chaff, open chaff, and so on. In the grain there is the shape, size, colour, hardness, softness, strength, etc. The knowledge that these segregate according to law is a vast step. It is another immense advance to know definitely when a character will breed true ; but it still requires much patient work to secure just the combination most desired.

The first wheat considered good enough for distribution by the Home-grown Wheat Committee of which Professor Biffin is a member was named Burgoyne's Fife, and it was the Report of the trials of this wheat in season 1911, which prompted these notes. The report is a scientific document because it is a statement of fact.

> "The Committee has suppressed nothing unfavourable to the wheat, and has published in these returns the opinions expressed by the growers themselves. It does not necessary endorse or dissent from any opinion expressed in these returns."

I have quoted these sentences because, in my opinion, they express the essence of the scientific spirit.

As in Australia, so in Britain, no one variety will suit all conditions equally well, but the reports show that Burgoyne's Fife is succeeding under as wide a range of conditions in Britain as is Federation wheat in Australia. The wheat has also been thoroughly tested in the mill and has proved to resemble the best Manitoba wheat, being:—

> "so much superior in baking qualities to average English wheats and fit, if needs be for use by itself in the manufacture of flour for the best London trade."

The tabulated reports show that the yield varied on the 39 farms where it was grown on a commercial scale from 20 bushels to 56 bushels per acre. Only three were under 30 bushels. Twenty were over 36 bushels, and twelve over 40 bushels to the acre. The remarks of growers are most interesting. One states:—

> "The quality of grain superb. Won 1st prize and champion for all wheats shown at the United Farmers' Club Grain Show, 1911. Said by judges to be equal to the best Manitoba."

Others report that it is worth 3s. to 4s. per quarter (4½d. to 6d. per bushel) more than other English wheats. Every grower reported that he intended sowing it again.

THE PROTOZOIC ROCKS OF THE NORTH OF WESTERN AUSTRALIA. BY LUDWIG GLAUERT, F.G.S. (Read March 12th, 1912.) *Communicated by permission of the Director of the W.A. Museum*, B. H. WOODWARD ESQ.

I propose this evening to confine my remarks to the northern portion of the Continent (1) to the North West of the Northern Territory, where the researches of Messrs. H. J. L. Brown and H. Basedow have yielded facts and conclusions which will enable us to unravel some of the problems of Western Australian geology; and (2) to the Kimberley district, where the late E. T. Hardman discovered fossils which, unknown to him and probably quite unexpected by him, furnish the first palaeontological proof of Protozoic or Older Palaeozoic Sediments in Northern and Western Australia.

Owing to the inaccurate reading of Hardman's labels the localisation seemed to be so vague as to render scientific use of the discovery hazardous in the extreme.

In 1906 Mr. R. Etheridge writes in N.T. of S.A. North-West District, Geological Reports resulting from the explorations made by the Government Geologist and staff during 1905, on page 42, when referring to Hardman's fossils, that:—

> "Unfortunately the . . . . specimens were very poorly localised and I have quite failed to identify his precise locality."

And at a later date (1907) Mr. A. Gibb Maitland sums up the situation in the following terms (G.S W.A. Bulletin 26, page 48):—

> "Despite the fact of the poor localisation of Hardman's fossils, it may, I think, be taken for granted that Cambrian beds do occur somewhere in Kimberley about South latitude 18 ."

A few months ago I decided to investigate the matter, with a view of attempting to solve the problem. I carefully examined a number of reports and documents dealing with these Cambrian fossils, and in a Contribution to the Records of the W.A. Museum, now in the Press, have determined the exact position of three localities where Hardman collected *Olenellus Forresti* and *Salterella Hardmani*.

Although I am not permitted to enter into the matter at the present juncture, I may say that inaccuracies in the first published descriptions as they appear in the Geol. Mag. Decade III, Vol. VII (1890) are responsible for the confusion that has arisen. And out of fairness to the late E. T. Hardman I must add that as far as I am able to judge Hardman's localisations are sufficiently accurate to guide subsequent investigators to the outcrops which yielded the *Olenellus* and the *Salterella* in 1884.

In the Northern Territory the results of Hardman's discoveries have long been applied to practical use. The Cambrian rocks of the Territory, unlike those which have been provisionally classed as Ordovician, may be divided into two groups—the *Southern* facies, extending from South Australia proper as far as Tennant's Creek, in the N.T., contains mudstones or compact shales which carry a Trilobite fauna, including *Olenellus* and two diminutive genera, *Agnostus* and *Microdiscus*; and the *Northern* and *Eastern* facies, which is essentially a limestone formation pure and simple, though interbedded sandstones are found at the Fergusson River.

Mr. H. Y. L. Brown has described a typical outcrop in the following terms (l.c., p. 14):—

> "Outcrops of the rock two miles north of Noltenius Billabong, and about nine miles from the Daly River, consist primarily of a compact blue grey and yellow subcrystalline limestone, parts of which are rich in pteropod tests of *Salterella*, weathering slightly in relief. The beds are horizontal, and the line of outcrops trends north westerly. No deep section is available, and wherever encountered the outcrops rise but a few feet above the surface. The physical features are low, banked, denuded tables separated by horizontal joint planes and piled one upon the other, the uppermost being very much smaller than the lowest visible, which rest upon massive beds of the same rock below. The exposed surfaces have been eroded in a remarkable manner by the atmosphere, and appear in the form of sharp confluent serrated ridges grading downwards on all sides; the whole giving the effect of a model of mountain chains on a small scale. The rocks thus decompose comparatively readily and produce a rich red clay soil.
>
> "The beds overlie unconformably the schistose Pre-Cambrian rocks on the East and West. On the West of Mount Shoobridge the beds rise to greater altitude, as isolated outliers, and are overlain by more recent sandstones.
>
> "In lithological characters this formation is similiar to that covering large areas between (1) the Katherine Station and Flora Falls, also to that at (2) Jasper and Timber Creeks, off the Victoria River; (3) between the Elsey and Daly Water Stations on the Transcontinental Telegraph line, and (4) Anthony's Lagoon, (5) Brunette Downs, (6) Alexandria Station, and other places. It is most probably continuous beneath the basalt, sandstone and other later formations. The occurrence of Cambrian fossils near the Daly River and Alexandria Station prove that these widely separated expanses of limestone are identical in age."

Glancing at the description published in the various reports dealing with the geology of the eastern portion of Kimberley we find the Ord River district presents numerous patches of limestone

Dr. Jack (in G.S.W.A. Bulletin 25) maps and describes two bands of hard limestone of undetermined age dipping at a steep angle; these he regards to be the summits of an ancient range almost entirely submerged by the lava flows which now form the well known Argyle Downs. Similar bands of limestone are seen in the flank of the Albert Edward Range, a considerable distance to the South West, where the basalt is absent. The indurated rocks forming the eastern escarpment of the range are evidently younger than the metamorphosed schists, etc., which contain the gold-bearing lodes and veins of the Goldfield and include in their number several bands of limestone of various thicknesses, which in my opinion correspond with the *Pre-Cambrian Limestones* in the N.T. and furnish the Knife Edges of the Argyle Downs.

The other outcrops of limestone are generally described by Hardman in the following terms (p. 123):—

> "This portion of the limestone country rises in a succession of low and almost imperceptible terraces into high table lands. One of these extends to the east of the Ord near the Cattle Station and another to the north and east of the Negri River, where it is capped by Mt. Panton.
>
> "The Ord limestones are for the greater part hard and flaggy, rarely massive, usually grey in colour, sometimes sandy or magnesian, and seldom fossiliferous. In many parts of the district they are interbedded with red shales, marble and sandstones, the former of which contain occasionally layers of gypsum together with traces of rock salt.
>
> "Over a great part of this country the limestone crops out in bare masses, cut through by gullies and watercourses, along which the rock often forms high cliffs and scaurs showing the stratification which dips at a very low angle in various directions very distinctly . . ."

The rock is said to weather into tabular masses exactly similar to those described by Mr. Brown at Noltenius Billabong; and as that typical Cambrian fossil *Salterella* has been found by Hardman in the valleys of the Elvire and Ord Rivers and at Mount Panton, over the N.T. border, and further, as Mr. H. W. B. Talbot, of the Geological Survey of this State, obtained the same fossil at the Homestead on the Ord River Station a couple of years ago, in limestone that cannot be distinguished from specimens obtained in the Northern Territory, it is evident that several if not all the limestone outcrops in the Ord River district are of Cambrian Age.

It may also be noted in passing that, as in the Cambrian limestone districts of the Northern Territory, the superficial deposits resulting from the weathering and disintegration of the limestone form a rich red soil.

The objection that Hardman collected and reported Carboniferous fossils from Mount Panton thus proving the presence of Carboniferous beds in the district may be met by the suggestion that there, as in various other parts of the Northern Territory, the Cambrian beds are capped by beds of later age.

The presence and extent of the Cambrian Beds having been proved, we may venture to utilise the information gained, with a view of identifying and correlating the other beds with which they come into contact.

Hardman reports that on the north bank of the Ord and Elvire the limestones are seen to pass conformably under other sediments which he describes as being "micaceous red shales and mudstones with a few bands of limestone and larger masses of white, red and grey flags and grits," in no section was any unconformity observed.

These beds are of fair extent in the Elvire and Ord River valleys and from information which I have obtained from a reliable observer, differ in no wise from beds which extend from the Albert Edward Range and Mt. Timperley to the South-East and South-West for some considerable distance. They present the same physical features and like them are almost, if not quite, horizontally bedded.

The age of these beds cannot as yet be determined by their fossil contents, for up to the present no signs of animal or vegetable life have been discovered in them. Turning to Mr. Brown's invaluable report of work done in 1905, we find that similar rocks are exposed over the border. An area of rocks, bounded on the North by the sandstone McAdam Ranges and on the S.E. by the Sea Range, presenting these characters has been mapped by Mr. Brown as being most probably of Ordovician Age. They have so far yielded no signs of ancient life, but their lithological character so closely resembles that of undoubted Ordovician beds of the McDonnell Ranges that this great authority, who knew his South Australia so well, provisionally assigned them to the same geological period.

Mr. Brown's map of 1906 shows that these rocks extend to the Western Australian border, where, of course, his work terminated. Placing his map at the side of that prepared by Dr. Jack, for G.S.W.A. Bulletin 25, we find that this same series extends westwards towards the Cambridge Gulf, where the rocks rise to form the well-known House Roof Hill and the Bastion Ranges.

Crossing the Gulf, they are shown by Mr. Maitland's sketch map of 1907 to fringe the coast as far as 127° E. and 140° S. past which point they do not appear to have been traced.

In a southerly direction they make their appearance at Mount Elder, south of the Negri River, and on the northern side of the Ord, extending from Glass Hill to the western end of the Dixon Range, both these patches lie conformably upon the limestones, which gradually pass into them.

Opposite the southern end of the Albert Edward Range they are found to rest unconformably against the older rocks of the range and to occupy the whole of the large basin or trough-like hollow which extends away to the south. It is therefore not surprising that no Cambrian limestone was met with by Mr. Talbot on his traverse from Wiluna to Hall's Creek along the Canning Stock Route.

The southerly boundaries of these Ordovicians are unknown. Mr. Brown's map of the Northern Territory and South Australia, published twelve or thirteen years ago, shows that the beds extend considerably to the east of the 129th parallel. And Mr. Talbot's work done in connection with the Canning Stock Route fixes the S.W. boundary at approximately 22½° S. and 123° E.

How far they extend in other directions is not known, though we may assume that they cover practically the whole area between the Stock Route and the South Australian border. To the north-west of the route they seemed to stretch for many miles. The auriferous belt of Hall's Creek does not appear to extend further to the south-west than is shown on Dr. Jack's map, for as far as is known to me, prospectors have failed to locate any metaliferous outcrops in that direction. And all accounts of traverses of the sandy desert point to the fact that the class of country remains unaltered right to the Ninety Mile Beach.

At their south western extremity and in the vicinity of the Albert Edward Range, these undoubted Ordovician Beds are seen to rest unconformably against rocks which have previously been classed as Devonian. Wherever these older rocks are exposed they consist of the same indurated sediments usually argillaceous or arenaceous, but at times including bands of limestone.

They cover a large area in North Kimberley and are also well developed in the North West Division, where they have been mapped by the Government Geologist and Mr. H. P. Woodward. I feel convinced that in the Kimberley District, at any rate, these beds are much older than Devonian ; they underlie the series which I propose to name the Ordovician, and although not seen in actual contact with the Cambrian Limestones, must pass under them, too, for obvious reasons, for them I suggest the name of Pre Cambrian.

In the Albert Edward Range some fine sections are to be seen which show the Archaean complex of the Hall's Creek series, unconformably under these Pre-Cambrian, which in their turn have the horizontally bedded Ordovicians resting against their upturned edges.

In the Kimberley district we therefore find that the true Carboniferous beds are confined to the western portion south west of a line joining the Oscar Ranges with the coast.

In the other parts of the division a much older sequence is presented. The sediments there consist of :—

Shales, sandstones, grits, etc., of *Ordovician* (?) Age, previously classed as Carboniferous, Fossiliferous Limestones of *Cambrian* Age, previously classed as Carboniferous, Indurated Sediments referred to as *Pre-Cambrian* previously classed as Devonian,

and an altered and metamorphosed series, the gold-bearing beds of the District, which are much older than the preceding and are termed *Archaean* to distinguish them from the later Pre-Cambrian rocks.

These conclusions are confirmed by palaeontological evidence of fossils found and by the careful and thorough work done by Mr. H. Y. L. Brown in the Northern Territory, which enables us to trace several exposures across the border.

Whilst admitting the difficulty of undertaking work of this kind from an arm chair, I feel thoroughly convinced that the foregoing conclusions are correct.

AN INVESTIGATION INTO THE STRUCTURE AND FUNCTIONS OF THE SKIN OF THE POTATO TUBER. BY F. STOWARD, D.Sc. (Read April 16th, 1912.)

PLATES XIV. TO XVII.

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INTRODUCTION.

It is, perhaps, scarcely necessary to do more than simply indicate the economic importance of the potato tuber. The fact that it serves as a human food-stuff, and that it represents the starting point of at least two industries of colossal magnitude starch production and industrial alcohol —are sufficient to stamp it as a vegetable product of first importance. Nevertheless, that so common-place an object as an ordinary potato-tuber may serve as promising material for the purpose of a biological or physiological enquiry may at first sight appear to be doubtful. It may be contended that so well known a product must surely have been subjected to thorough investigation. The fact cannot be denied: the potato-tuber has undoubtedly been investigated from various standpoints—the biological, physiological, chemical, and, during recent years, pathological standpoints; but the general result of these investigations has been to stimulate further enquiry, and to develop new lines of research. One of the invariable results of scientific investigation, using the phrase in its proper meaning, is to open up new avenues of research.

However complete an investigator's work and its attendant results may have been in any particular field of enquiry, there still remain areas which have not been covered.

The cultivated tuber, in common with other plants, is subject to attack from various natural parasites. These may be of fungoid, bacterial or animal origin. Among the aims of the young science of plant pathology is the study of these disease producing organisms, with special reference to their life histories, modes of attack, and the nature of the pathological changes induced by them in the plant attacked. Such studies, when directed to economic ends, lead to attempts to devise and develop means calculated to prevent or suppress certain plant diseases. The success or non-success of these means depends in great measure on the extent to which scientific enquiry has been able accurately to elucidate the actual nature of the causation of diseases in plants.

During recent years a considerable amount of investigative work has been devoted to the study of the destructive action of various powerful poisons on parasitic organsims. The treatment of tubers affected with the fungous disease known as "scab" furnishes a concrete example of this mode of treatment. "Scab" infected tubers are steeped in aqueous solutions of formalin or corrosive sublimate, with the object of destroying the infecting fungus. The duration of immersion being so selected as to not seriously impair or endanger the vitality of the buds of the treated tubers. Obviously the question presents itself whether absorption of these poisonous substances occurs under the conditions of treatment selected. If absorption of the poison is postulated the further question presents itself whether absorption takes place through both buds and skin, or buds alone. Careful search through the literature at my disposal has so far failed to throw any light on this question, which would lead me to consider that it has hitherto been made the subject of any special enquiry. It will be evident whether or not the poisonous substances mentioned, or other soluble chemical substances, permeate the skin of the steeped tuber, turns largely on the structure and properties of the skin itself, and in particular on its behaviour towards chemical substances in solution; in other words, the development of the subject obviously rests mainly on the manner in which the skin functions in regard to its permeation by these substances.

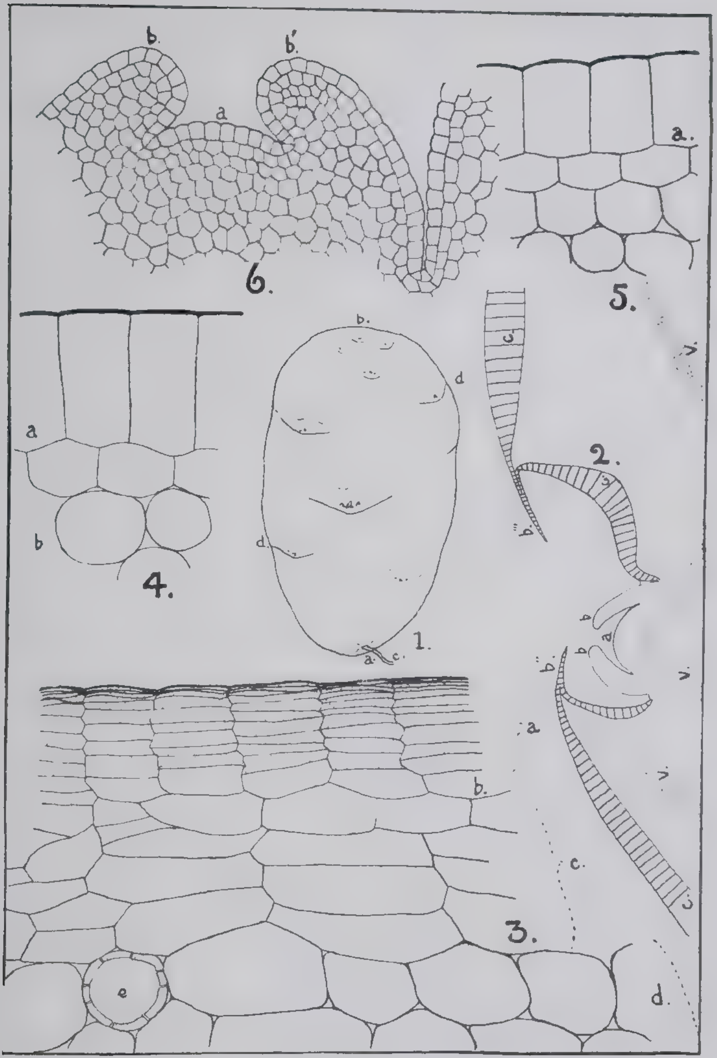
The present paper accordingly comprises a short account of the skin of the tuber, with special reference to certain of its functions and properties.

Briefly stated, the main divisions of the subject include:

(1) The *morphology* (external form and characteristics) and *histology* (minute anatomy) of the tuber, with special reference to the skin and its protective function.

(2) Some of the more obvious effects attendant on experimental mutilation of tubers as evidenced by sectioning, removal of the skin, or excision of the "eyes."

(3) The retardative influence on the loss of weight by tubers as a result of the treatment of "cut sets" with certain chemical substances, and the subsequent influence on plant growth exercised by such treatment.



Figs. 1—6.

Sections of Potato Tubers.

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(4) The comparative impermeability of the skin of the tuber to water and certain salts and acids in solution.

THE MORPHOLOGY OF THE POTATO TUBER.

The principal morphological characters as presented by an ordinary well-grown tuber are not difficult to determine. It may at once be asserted that it represents a short, much thickened part of an underground structure, which, on casual observation, would probably be regarded as a root. If it be desired to express this in formal botanical terminology, then this underground apparently root-like structure is designated by the word *rhizome*, and its enlarged (and in this case terminal) portion by the word *tuber*. In point of fact it would be difficult to find an object which more aptly illustrates the botanical definition of a tuber than the potato. That the rhizome is actually an underground stem, and not a root, and the fact that tubers are borne on rhizomes and not on roots, is rendered apparent by a comparative wealth of convincing evidence, each item of which may, if desired, be readily subjected to independent verification. In the first place we have the fact that the structures bearing the tubers arise from buds in the axils of the vegetative leaves, and hence they are regarded as branches of the stem. The rhizome, it may be further stated, in order to obviate any misapprehension in regard to its origin, a rises exogenously, that is to say, from the superficial layers lying towards the peripheral or cortical portion of the stem, which it will be recalled arises during the course of its development from the periblem. Another point of difference between rhizomes and roots which may be noted is that the rhizome is provided with an apical bud; a root, on the contrary, has a root cap. Again, rhizomes bear scale leaves at distinct nodes. Roots never bear leaves. Finally, the internal anatomy of the rhizome is that of a stem.

We may now turn to the gross structure or external morphology of the tuber. Two well-marked regions are distinguishable: the "heel" or basal portion (Fig. 1*a*), to which the withered remains of a part of the rhizome is usually found attached, and the "rose" (Fig. 1*b*) end or apical portion. At the surface of the tuber are the "eyes" (Fig. 1*d*) arranged in a spiral. These are invariably more crowded towards its apical or "rose" end. Each "eye" appears as a collection of buds lying in a depression which usually, in very young tubers, may be readily identified as the axil of a scale-leaf. As the tuber develops these scale leaves wither and are lost to view, so that in mature tubers these units are rarely present. Each "eye," as already stated, is a collection of small buds; in fact, it is virtually a *lateral branch with undeveloped intenodes,* such as we might imagine if on an ordinary stem all the leaves with their auxiliary buds were subjected to an upward thrust, with the result that all the structures were raised to its summit and there closely pressed against each other. Thus the whole tuber does not represent, as is sometimes popularly supposed, a simple shoot, but a very much branched *shoot system.*

THE HISTOLOGY OF THE POTATO TUBER.

So far we have considered the gross or external anatomy of the tuber, and have become more or less conversant with those characteristics which may be recognised and identified by the unaided eye.

It is essential, in order to become acquainted with the minute anatomy or histology of the tuber to examine thin slices or sections of it under the lower magnifying powers of the microscope. These thin slices may be readily enough prepared from fresh material either as hand-cut sections or the material after fixing and suitable subsequent treatment may be embedded in paraffin and sectionalised with a microtome. Assuming that we have such a thin section properly mounted, and on the stage of the microscope in readiness for examination, then starting from without and working inwards, the following structures will be met with in the order given :—

(1) The skin (Fig. 3*a*), consisting of several layers of rectangular cells, arranged with their longer axis parallel to the surface.
(2) The phellogen or cork cambium (Fig. 3*b*).
(3) Transitional cells (Fig. 3*e*).
(4) The parenchymatous cells (Fig. 3*d*), large isodiametric cells, the protoplasm or living substance of which is more or less crowded with variously sized starch grains and other less conspicuous inclusions.
(5) Strands of vascular tissue and sclerotic cells in certain cases, the latter figured in Fig. 3*c*.

We may consider each of these various tissues and structural units in more detail. Commencing with the skin we may note that the cells which constitute its outermost layers are apparently devoid of protoplasmic contents and inclusions; and it is doubtful whether these extreme outer layers are composed of actively living cells. The investigation of this point is a matter of difficulty, seeing that neither plasmolytic tests nor *intra vitam* staining afford evidence which can be regarded as conclusive. The inner-most layer of these cells (Fig. 3*b*) constitutes what is known as the cork cambium or phellogen ; the special function of which is the production of new cork cells. Micro chemical tests indicate that the walls of these cork cells contain suberin, the presence of which confers upon them their corky character. At least, the application of the customary reagents affords evidence which is usually accepted as demonstrating the presence of this substance in vegetable tissues. Possibly no reagent of those so far employed yields better results than Tison's gentian violet-ammonia reagent. If thin sections of the skin of the tuber, after passage successively through water and Eau de Javelle, are placed for twenty four hours in a dilute solution of gentian violet rendered almost colorless by the addition of ammonia, then partially discolorised by placing them in an aqueous solution of 8% hydrochloric acid, it will be found that the layers of cells forming the skin are deeply stained by the dye. Staining by this method is particularly useful, in that only the walls of the cork cells of the skin retain the stain, and thus enables one to differentiate these cork cells from those of the underlying tissue, the walls of which are composed of cellulose. There is one exception to which, however, it will be convenient to refer to later.

Immediately subjacent to the skin, varying in size and form in different varieties of tubers, sometimes compressed and elongated, at others more or less isodiametric, are cells which are known as transitional cells (Fig. 3*c*). Their particular function is not distinctly known, and it is quite an open question whether they do not possess a dual function ; that is to say, these units may possibly behave either as cork cambium cells or as parenchymatous cells. As we shall presently see, these transitional cells on mutilation, as occurs when a tuber is cut or bruised, are capable of forming wound cork, a phenomenon we shall consider in some detail when we come to deal with the results induced by mutilation of the tuber. The appearance of sections stained with Tison's reagent negatives the presence of suberin in the walls of the transitional cells.

Turning once more to the exploration of our section we find, lying immediately beneath these transitional cells, large conspicuous cells, which form by far the greater mas of the tuber. These parenchymatous cells, as they are termed, constitute a magazine in which carbohydrate material in the form of starch is stored. Each parenchy matous cell represents a small compartment of this store house in which certain of the end products which arise as the result of the metabolic activities of the vegetative or above ground parts of the plant are stored.

Generally, if the section is carefully examined, we find here and there among the parenchymatous cells other cellular units, oval or circular in cross section, possessing thick walls with transverse markings, and presenting in their superficial view a pitted appearance. The walls of these cells, when stained according to Tison's method, assume a magnificent blue colour. Their resemblance to the stone cells met with in the pulp tissue of the pear is striking. These cells bear the distinctive name of "sclerotic cells" or "stone cells" (Fig. 3*e*).

Their origin, nature, function and possible significance is, for the present, a matter of conjecture. At one time it was supposed that the presence of such cells was an indication of advanced ripeness. The fact that many are met with in quite young tubers, however, renders this view untenable. Appel regards these cells rather as representative of a varietal characteristic and very reservedly suggests that their presence may be accepted as a possible indication that the varieties of tubers in which these units are present have arisen directly from sclerotic types, or possibly by hybridisation from sclerotic types. This view, whatever may be its ultimate value, evidently suggests an hereditary origin for these sclerotic cells.

Lastly, we come to the vascular elements (Fig. 2*v*), which, in most sections, appear as shreds and patches due to the fact that these structures are irregularly disposed in relation to the plane of the section. These vascular strands are tubular structures, forming a more or less intricate conducting system, and representing an extension of similar structures in the rhizome. They may be traced to the vascular system of the above ground parts of the plant. If carefully investigated by means of serial sections, it will be found that branches of this root system of vessels can be traced to each "eye" of the tuber. The vascular strands are the highways along which the translocation of the metabolic products formed in the leaves of the plant takes place, the most important of which are the carbohydrates, which are ultimately stored in the tuber as starch.

During the growth and development of the young crop tuber the processes which predominate are essentially those of mobilisation. During the period of after ripening, followed by the onset and continued progress of sprouting, the chief phenomena are those of immobilisation. The starch and also probably the proetin storage materials under the influence of certain specific enzymes become simplified and solubilised and thus rendered available for the nutrition of the growing sprouts.

The chief object of this paper, as its title is intended to imply, is a consideration of the physical properties and physiological attributes of the skin of the potato tuber.

Morphological and histological observations coupled with micro chemical tests, furnish information which is of a suggestive character only as to the possible rôle of the skin in the general economy of the tuber. The minute anatomy of the skin, the disposition of its layers, its cellular structure, and the demonstration of the corky character of the walls of these cells, all belong to the domain of descriptive data. Such data are admittedly essential and useful, but possess chiefly a suggestive or speculative value, in so far as concerns the functional attributes of the skin. on evidence of this kind we may conceive in a rough qualitative fashion that the skin of the tuber is a protective covering, and we may consider that the observations cited are entirely in accord with this view. In other words, histological investigation, as we have seen, is distinctly illuminative in regard to the structural features of the skin, but it is inadequate as a means of affording any very definite information as to the nature of the suggested protective function of the skin of the tuber. Experimental enquiry into the physiological attributes of a vegetable organ or tissue is often confronted on its very threshold by this difficulty; it frequently involves mutilation of the object which we propose to investigate. It is not, therefore, always possible to differentiate in how far the results which follow on mutilation are strictly physiological or pathological in character.

We will first consider experiments designed to ascertain the results, expressed in terms of the comparative loss of weight, attendant on :—

(1) Complete removal of the skin and eyes (peeled tubers).

(2) Bi-section of the tubers (cut sets) ;

and compare these results with those yielded by unmutilated but otherwise similar tubers. The selected conditions of experiment being similar for the three series, *i.e.*, the tubers being exposed to the same temperature and other external conditions. In each instance the loss of weight is calculated as a percentage on the initial weight of the material examined.

The data contained in the table beneath represent only a selection form several series of similarly performed experiments.

Table I.

Comparative losses of weight by mutilated and unmutilated tubers.

After hours	Peeled tubers		Eye-exercised tubers		Intact tubers	
24	24.24%	14.02%	2.22	2.42%		
48	31.87	22.4	4.05	4.29		
72	34.13	28.35	4.79	4.74	0.11%	0.10%
96	35.21	32.29	5.19	5.20	0.17	0.13
120	———		5.25	5.49	0.29	0.23
144	43.56	38.06	———	-	0.35	0.30
168	47.0	41.0	5.98	6.03	0.48	0.39

A glance at these results will show how considerable is the loss of weight by mutilated tubers as compared with intact tubers. Generally speaking, at any selected stage of the experiment the magnitude of these losses follows in descending order the direction peeled tubers, eye-excised tubers, intact tubers as, in fact, anticipation would lead one to suppose. If now we turn to consider the relative losses of weight after a period of 168 hours the results are striking. In the experiments under consideration these are 41-47%, or nearly half, the original weight for peeled tubers, 5.98-6.03%, or slightly more than 1/20th for eye-excised tubers, and 0.48-0.4% or 1/250th for intact tubers. These values alone strongly support the supposition already foreshadowed by histological observations, that one of the functions of the skin is to prevent rapid dessication of the tuber. Its removal, or even partial removal, in the case of eye-excised tubers, as these data show, leads to losses of weight which are greatly in excess of those lost by intact tubers. Such apparent irregularities as are shown in the rate at which loss of weight ensues in the case of peeled tubers are in part to be attributed to variability in the area of surface exposed, in part to other deeper-seated and less evident causes.

At the outset we must guard against the supposition that these weight-losses are due entirely to losses of moisture by the objects under investigation. In the case of peeled and bud-excised tubers other factors require recognition; the chief of which is the increased respiratory activity consequent upon mutilation of the tubers. In the case of intact tubers the loss of weight recorded in Table I are chiefly due to the excretion of carbon-dioxide; in other words, to the respiratory activity of the tuber. We may legitimately suppose that the values given represent roughly the daily loss due to normal respiration. The unsprouted tuber is alive, but it is in a quiescent vital condition.

It respires, but its energies, in this respect, are reduced to their lowest level of activity. When we mutilate a tuber, as happens in peeling it, two things result; on the one hand, respiration, *i.e.*, the taking in of oxygen and giving out of carbon dioxide, is increased, and this is accompanied by the formation of wound cork over the cut surface, and on the other, loss of moisture through dessication of the residual starchy tissue. The total loss immediately following mutilation is thus of a dual kind. If, for example, a tuber is injured by being cut up, as in the preparation of what are known as "cut sets" for seeding purposes, the respiratory exchanges, as shown by Richards' researches, are notably increased.

The output of respiratory carbon-dioxide in unit time is from five to eight times greater than that yielded by intact tubers. In several of Richards' experiments the tubers were merely bisected by slicing them lengthwise. In the above experiments with peeled tubers mutilation was much more extensive. It is therefore very probable that the losses in these experiments to be attributed to enhanced respiratory activity are much greater than those recorded by that author. The peeling or slicing of a tuber involves the wounding of the tissue and the increased respiration of wounded tissues, as shown by Richards' work, is referred to in the literature of plant physiology as a "wound reaction." A wound reaction is virtually the response of plant tissue to stimuli induced by injury. Other examples of wound reactions are to be seen in the healing phenomena which normally ensue after pruning operations.

To return to the tuber: immediately after injury the parenchymatous tissue, and as already stated the transitional cells also, make an effort to repair the damage caused by the slicing or peeling of the tuber, and thus check that rapid and considerable dessication of the storage tissue which ensues when the skin of the tuber is removed or mutilated. The formation of wound cork over the exposed surface, and the accompanying increased rate of respiration, are the outward and measurable expressions of this reparative effort. In the case of the mature tuber it is probable that this increased respiration is due chiefly to wounding alone, and not so much to renewed cell division, as occurs in tubers which may be still capable of growth.

In the common practice of preparing "cut sets" the phenomenon must evidently be of common occurrence. It will not, therefore, be foreign to the subject in hand, seeing that in many respects the functions of wound cork in the case of cut sets are very similar to those of the skin of the intact tuber, briefly to refer to certain experiments in which the study of the induced formation of wound cork has formed one of the principal objects of experimentation.

In these experiments the freshly exposed surfaces of the two cut sets prepared from each tuber were, immediately after cutting, lightly dressed with either freshly powdered air-slaked lime, sulphur or sand. These treated sets, and also untreated sets (controls) were afterwards exposed for 144-168 hours in order to note, as in the preceding experiments, the comparative loss of weight following on the application of the dressing and subsequent exposure of the experimental material.

Two series of experiments were thus prepared, and the material was finally planted in ordinary garden soil contained in shallow boxes, a small but uniform addition of an artificial potato-manure being made to each portion of soil. The conditions of exposure after treatment and during culture were similar within each separate series of four experiments; the two series were not, however, contemporaneous, one series (series 1) being planted earlier than the other (series 2).

The relative percentage losses of weight by "cut sets" under the various treatments are embodied in the tables beneath:—

Table II.

Percentage losses of weight.

Series I.—Four lots, 5 each, white thin-skinned tubers, treated as under:—

Experiment Sets treated with	1 Lime	2 Sulphur	3 Sand	4 Untreated [Control]
After 4 hours' exposure	1.74%	1.88%	1.78%	2.33%
,, 8 ,, ,,	3.94	4.19	3.81	11.8
,, 24 ,, ,,	9.98	13.98	12.14	15.1
,, 48 ,, ,,	15.96	17.02	16.37	23.4
,, 96 ,, ,,	18.59	20.03	20.64	–
,, 144 ,, ,,	22.20	23.69	24.08	27.3

Series II.—Four lots, 5 each, red thick-skinned tubers, treated as under:—

Table III.

Percentage losses of weight.

Experiment Sets treated with	5 Lime	6 Sulphur	7 Sand	8 Untreated [Control]
After 24 hours' exposure	7.35%	8.03%	8.48%	11.9%
,, 48 ,, ,,	11.98	13.88	16.38	17.91
,, 72 ,, ,,	14.99	17.48	19.35	22.09
,, 96 ,, ,,	16.9	20.02	22.74	25.40
,, 144 ,, ,,	19.37	23.91	27.03	30.51
,, 168 ,, ,,	20.54	25.81	28.86	32.41

The treatment of sets in the manner described with one or other of the substances used evidently leads ultimately to smaller percentage losses of weight than in the case of the untreated controls. The object of dressing "cut sets" with substances like those used in these experiments is to induce the more speedy formation of a protective covering of wound cork. This, as an examination of the percentage losses of weight in the above tables indicates, is evidently what happens during the earlier intervals of the entire period of exposure we find the losses of weight by the treated tuber sets are less than those of the untreated sets, and in addition the fact is shown that of the three substances used, air-slaked lime functions best. It will be evident from a survey of the results given that the comparative loss of weight by treated and untreated sets must vary with the kind of tuber and the conditions of experiment selected. Under comparatively low temperature conditions and in the absence of rapidly moving air currents, in other words, under conditions unfavourable to rapid dessication, the results yielded by tubers of the same kind as those used in Experiments 5 to 8 show the relative percentage losses of weight after 168 hours' exposure to be 16.67%, 17.11%, 18.35% and 19.01% respectively for lime, sulphur, sand and untreated tubers. Such conditions, however, do not always obtain in practice, and the fact remains that loss of weight by untreated sets is still in excess of that by treated sets. That the resultant smaller losses in the case of lime dressed sets is not due to the greater formation of wound cork is rendered probable by the following experimental facts :—

In another series of experiments similarly established to the foregoing, determinations were made of the weight of wound cork formed ; these, expressed as percentages on the original weights of the material taken were 2.21%, 1.9%, 2.7%, and 2.83% for the lime, sulphur, sand and untreated sets respectively. Considering the nature of the material dealt with, these values do not differ greatly, and the view may be advanced that the efficiency of the various dressings depends primarily on the rapidity with which the induced formation of wound cork is conditioned by their use. The results of these experiments are not devoid of practical interest. We have the fact that under ordinary circumstances cut sets lose weight, which it is true may show considerable variation, and this increases with the extension of the interval between preparation and planting. Such losses are certainly not favorable to the vitality of the buds of the tuber. On the contrary, there is really every reason why the freshly exposed surface of the cut set should develop its layer of wound cork as quickly as possible, and the more rapidly this takes place, or may be induced, the better.

Again the possibility of infection by both fungous and bacterial organisms resident in the soil which are pathogenic or disease-producing to the cultivated tuber is always existent. The barrier of wound cork must at least be an obstacle to the ready entry of these organisms. Its rapid formation in some measure amounts to the interposition of a first line of defence against invasion.

This view may *a fortiori* be advanced when we recall Myoshi's experiments of long ago—experiments confirmed and extended by subsequent investigators—which showed how slender and artificial is the line of demarcation between saprophytic and parasitic organisms. The experimental injury of a plant tissue, for example a minute wound made by puncturing a tissue with a sterilised needle, the introduction at the point of injury of what were formerly regarded as obligate saprophytic organisms, that is, organisms which live on *dead* matter exclusively, and the acquisition of parasitic functions by these same organisms, widened the highway of plant pathology and indicated a line of enquiry into the possible origin and nature of parasitism as exemplified by the lower fungi.

The apparently beneficial effect of the treatment of cut-sets with air slaked lime is reflected by the planting tests. In both series not only did the limed sets (Experiments 1 and 5) sprout earlier than the other members of the series, but their rate and luxuriance of growth was also superior. It does not seem very probable that the comparatively minute amounts of lime introduced with these sets could have exercised any direct chemical stimulus, although such an influence is not entirely excluded. As the accompanying photographic representations (Figs. 9-12) of these experimental series taken 38 days after planting show, and observation confirms, the comparative luxuriance of growth during this period was most advanced in the case of the lime-dressed sets.

These results, taken in conjunction with those given in Tables II and III, apparently show that the two chief factors are (1) the reduction in the loss of moisture which in its turn is dependent on (2) the more rapid formation of cork in the case of dressed tuber sets. These experiments also furnish a rational explanation of the principle underlying the practice of dressing tuber-sets with substances which stimulate the more rapid formation of cork over the freshly-cut surfaces of the sets than occurs with the untreated sets.

So far we have seen that both on histological and physiological grounds the skin of the tuber is an eminently protective layer. Its complete or partial removal leads to loss of weight, which is considerably greater under comparable conditions of experiment than those afforded by intact tubers. Among the functions of the skin then are the prevention of this loss, and the protection of the storage tissue and its contents.

The formation of cork over the newly exposed surfaces of the freshly cut tuber, as we have seen, is a phenomenon of considerable biological importance. The fact has been demonstrated that its speedier formation may be artificially produced by the use of certain chemical substances, the most efficient of which is air-slaked lime.

THE COMPARATIVE IMPERMEABILITY OF THE SKIN OF THE TUBER TO WATER AND CERTAIN SALTS AND ACIDS IN AQUEOUS SOLUTION.

Earlier in this paper reference has been made to the practice of steeping tubers in various antiseptic solutions, such as formalin, corrosive sublimate, etc., as a means of destroying micro-organisms, chiefly fungi (and their spores), a number of which comparatively modern investigations in the domain of plant pathology have undoubtedly shown to be the causal agents of certain diseases of the potato tuber. The customary procedure is to prepare a solution in water, usually of one or other of the two compounds mentioned, which possess highly poisonous properties, and to steep tubers to be used for seed purposes in these solutions. The strength of solution, the duration of immersion, the subsequent method of handling the treated material, are matters governed more or less by arbitrary convention. No investigation, so far as the writer is aware, having the specific object of ascertaining whether these substances are capable of penetrating through the skin of the tuber and thus entering its storage tissue has been made.

The question naturally arises whether the skin is freely penetrable to water, and to salts or acids in solution. We may at once turn to the consideration of the question whether water readily passes through the skin of the tuber, and after having disposed of this point we may then be in a better position to study the behaviour of the tuber on steeping in water containing substances—salts or acids in solution. We may then compare and contrast the effects of removal of the skin in relation to the entry of substances in solution into the starchy tissue of the tuber. Finally, we may turn to the changed permeability of the skin due to the ravages of the fungus of Potato Blight.

THE ABSORPTION OF WATER BY TUBERS.

A number of experiments were carried out with two varieties of tuber, one (*a*) being a thick, red skinned, and the other (*b*) a thin, white skinned tuber. In each case a third series (*c*) of peeled tubers was established. In each experiment definite numbers of either intact unsprouted tubers, or peeled tubers, were selected, weighed, steeped in water for ten hours, and after drying superficially were at once re-weighed. The data give in the table beneath represent the percentage of moisture absorbed :—

Table IV.

Percentages of water absorbed by intact tubers, and peeled tubers.

1.	0.29%	0.41%	6.33%
2.	0.55	0.55	—
3.	0.21	0.79	7.72

These results, although showing a considerable range of variation, evidence the fact that although water is not freely absorbed by intact tubers, it is by peeled tubers. From the fact that after a few hours' exposure in an airy space this excess moisture readily evaporates from intact tubers, it is safe to conclude that when the duration of steeping does not exceed ten hours the bulk of the water taken up is solely absorbed by the skin, and that very little if any moisture penetrates into the starchy tissue of the tuber.

THE STEEPING OF TUBERS IN BRINE AND OTHER SALT SOLUTIONS.

In the preceding section the evidence advanced points to the fact that water does not readily penetrate through the skin of the steeped tuber.

It appeared desirable to investigate the behaviour of tubers in regard to the apparent impermeability of their skins by steeping intact mature tubers in solutions of common salt (NaCl). Undamaged tubers were therefore steeped in solutions of common salt of 10% and 15% strengths for eight days. During the progress of these experiments samples of the brines were removed and determinations made of their salt contents. An example of one of these trials selected from a number of closely similar and similarly conducted experiments is given below :—

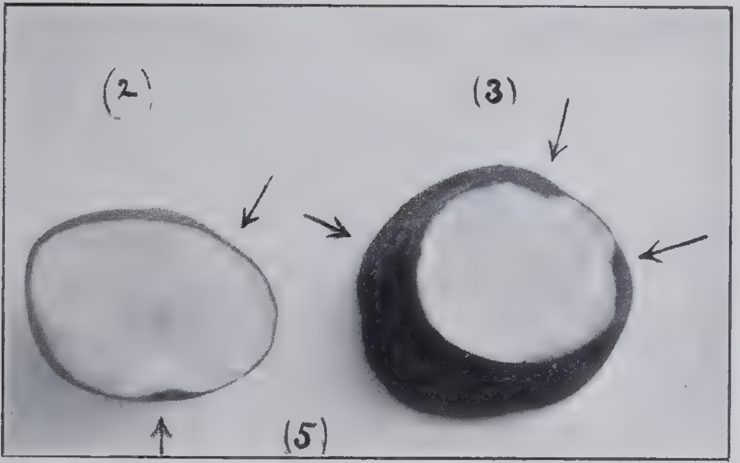

Fig. 7. Fig. 8.

Cross-sections of (7) blight-free and (8) blight-infested tubers. The arrows indicate the positions of the "eyes."

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Grams of chloride calculated as NaCl per 100cc of Solution.

Tubers steeped in	10% brine	15% brine
At commencement of experiment	9.65	14.53
After 2 days' steeping	9.71	14.43
,, 5 ,, ,,	9.83	14.46
,, 8 ,, ,,	9.69	14.19

As the above results show, commencing with brines of 9.65% and 14.53% strengths, the amounts of salt which are absorbed as shown by the decrease in strength of the solution is relatively small. These steeping experiments were conducted in open vessels, and consequently no attempt was made to control evaporation of water from the surfaces of the brines. While loss of water by evaporation tends to *increase* the strength of the brine solution, absorption of salt by the steeped tubers tends to *decrease* it. At every stage of the experiment, therefore, in attempting to follow the change of strength of the solution, what we actually measure is the resultant of two opposed processes. The values afforded by these experiments really show that finally salt is absorbed by the steeped tubers.

More satisfactory proof of this statement is furnished by determinations of the amounts of chlorides in untreated tubers and in tubers which had been steeped for ten days in brines of 10% and 15% strengths respectively. The material in these experiments was carefully dried, its moisture content determined, and the residue after dessication was repeatedly extracted with water, the chlorides being determined in the extract by the customary volumetric method.

Table V.

Percentage of chlorides calculated on air-dried tissue.

	Chlorides (calculated as NaCl)	Approximate relative increase in salt content.
Intact untreated tubers	0.28%	1
Intact tubers after 10 days' steeping in 10% brine	0.25	1
15% brine	0.54	2

The amounts of salt absorbed by intact, *i.e.*, unpeeled tubers obviously is relatively small, even after ten days' steeping in strong brines, and the deduction to be made from these experiments, although the permeability or non-permeability of the skin of the tuber to salt in solution is not definitely proved, is that it is certainly not freely permeable.

We may in an indirect way strengthen this conclusion by removing the skin and steeping the peeled tuber, thus prepared, in brines. In the following experiments, typical of several similar essays, are given the results of determinations of the change in the strengths of the brines used at intervals during the progress of these experiments.

Table VI.

Grams of chlorides expressed as NaCl per 100 cc of solution.

At commencement of experiment ..	4.27	9.32	17.91
After 5 days' steeping	3.77	6.58	11.93
,, 6 ,, ,, ...	—	6.58	11.84

It will be noted that as the result of the removal of the skin of the tuber, common salt rapidly and freely diffuses into the peeled tuber. This process of diffusion as the above analytical data show, proceeds rapidly at first, but from the fifth day and probably earlier the rate of diffusion slows down until about the sixth day a state of balance is attained and a point is reached at which the rates of entry and egress of salt into and from the steeped oojects are practically equal.

As in the preceding series, the absorption of salt by peeled tubers may be directly investigated and a more accurate measure made of the actual salt absorptive capacity by estimation of the amounts of chlorides in the material itself. Below are given the data afforded by such a series of determinations :—

Table.

Percentage of chlorides calculated on air-dried tissue.

	Chlorides (Calculated as NaCl)	Approximate relative salt content.
Peeled tubers (untreated)	0.28%	1
Peeled tubers rfter 6 days' steeping in 10% brine	2.29	10
Peeled tubers after 6 days' steeping in 20% brine	4.96	20

Comparison of these experiments (peeled tubers and the foregoing (intact tubers) evidently shows that the skin presents a barrier which greatly retards the entry of common salt into the tissue of the tuber. This impermeability of the tuber to salts in solution is undoubtedly an important biological factor. Important as the skin may be as a barrier to bacterial and fungoid invasion, it is equally essential that the reserve substance of seed tubers when planted in the soil should have ample protection. Free

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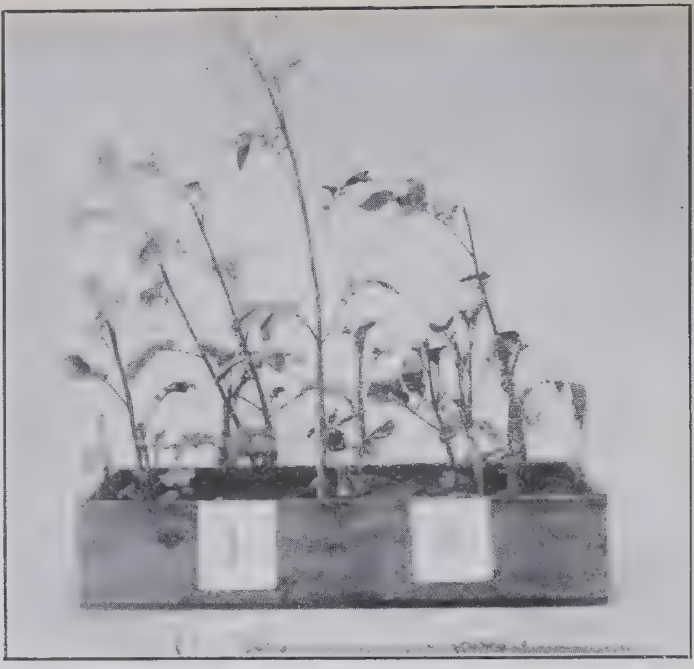

Fig. 9.

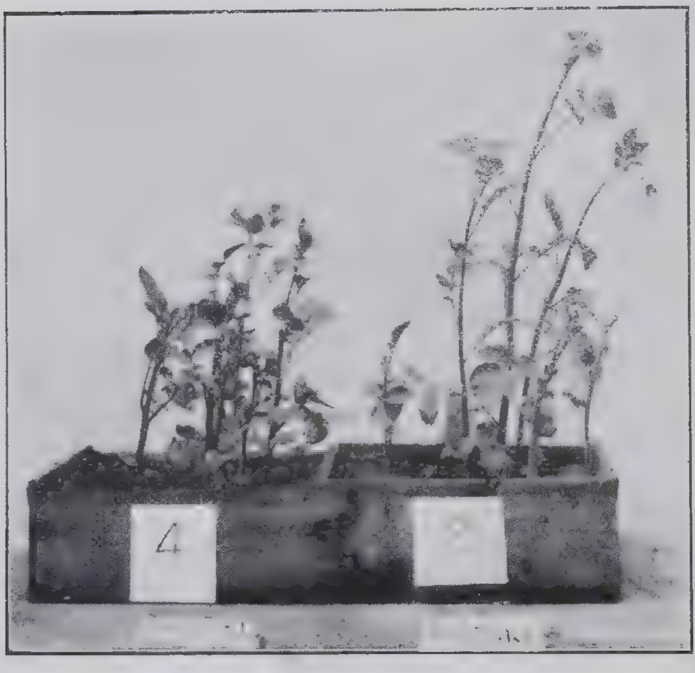

Fig. 10.
Illustrating influence on growth exercised by various treatments of "cut sets."

and unrestricted diffusion, for example, of soluble salts in the soil into the tissue of the tuber might be disastrous, especially during the period prior to the establishment of the young plant when it relies entirely for its nutrition on the reserve storage materials in the planted tuber. When this period is passed and the young plantlet has developed its root system it regulates within certain limits its intake of soluble inorganic food materials from the soil.

Similarly established experiments with less mature intact tubers which were separately steeped in solutions of the following compounds: nitrate of soda, nitrate of potash, sulphate of ammonia, of 10%, or in sulphate of iron of 1% strength, for variable periods of 10, 15 or 24 hours' duration, yielded results which parallel those afforded by similar material steeped in common salt solution. That is to say, in no single instance was there definite evidence pointing to the absorption by the tuber of any of these salts in quantity. Certain tests carried out with these tubers at first seemed to suggest that these salts stimulate sprouting. This was notably the case with those which had been steeped in sulphate of ammonia. Control tests, however, performed by steeping tubers in water alone, rather tend to discount this apparent result and render it equivocal. The question of this stimulative effect exercised by this treatment awaits further trial. The ground so far covered regarding the behaviour of the tuber when steeped in solutions of common salt and also the other salts enumerated indicates that the skin is practically impermeable to these compounds, but the evidence so far adduced cannot be said to show other than inferentially whether the comparatively small amounts of these various salts which are absorbed penetrate the tissue of the tuber solely by way of the skin or buds.

Experiments with acids and especially with sulphuric acid throw light on this question, and we may now turn with advantage to this portion of the enquiry.

THE STEEPING OF TUBERS IN SOLUTIONS OF ACIDS. THE IMPERMEABILITY OF THE SKIN TO SULPHURIC ACID.

(*a*) Blight-free mature tubers.

When well-ripened *mature* tubers with undamaged skins are steeped in solutions of sulphuric acid of 2.5, 5 or 10% strength for periods of time ranging from 1 to 20 hours, or even longer, the amounts of acid which are absorbed are relatively small, not amounting to more than about 0.09% of acid calculated on the total weight of the steeped material. A few concrete examples will render this statement clear and at the same time afford evidence of a tangible kind from which certain deductions may be drawn.

If tubers are steeped in a solution of 10% sulphuric acid for varying periods of time, and the amounts of acid present at the commencement and termination of the experiment are determined in a given volume of the solution, the relative amount of acid absorbed by the steeped tuber may be estimated by noting the *decrease* in the amount of acid in the external solution. Examples of such experiments are given below :—

Expt. 1.		Grams of acid per 100 cc of solution		Decrease in amount of acid per 100 cc solution.
	Duration of immersion.	at commencement of steeping.	at the termination of steeping	
A.	$2\frac{1}{2}$ hours	9.506	9.403	0.098 grams
B.	$4\frac{1}{2}$,,	9.408	9.408	0.00
C.	20 ,,	9.408	9.359	0.049

From the above data obviously the amounts of acid which diffuse from the acid solution into the tubers are relatively minute, and we may hazard the suggestion that just as in the experiments with salt solutions, the acid is not freely absorbed by the tuber. If we know the weight of the tubers taken and the volume of acid solution used in each of these experiments, then together with the above determinations we have all the necessary data for calculating the apparent percentage weight of acid absorbed. Taking, for example, experiment (A), we have weight of acid withdrawn from 1500 cc of solution = 15 x 0.098 grams, and weight of tubers 1650 grams, whence the percentage of acid apparently present in the tubers equals

$$\frac{15 \times 0.098 \times 100}{1650} = 0.089\%$$

The foregoing statement implies that the distribution of the absorbed acid is uniform throughout the substance of the tuber, but, as we shall see presently, this is not correct. We may, however, defer consideration of this point to a later stage.

Quite similar results follow on steeping intact tubers in solutions of boracic acid, although it is to be noted that this compound differs from sulphuric acid in certain important respects both as regards its chemical and physicochemical properties. The impermeability of the skin of the tuber to boracic acid is, to take an example at random, shown by the results of the following experiments :—Two lots of tubers were separately steeped in boracic acid solutions of (*a*) 1.61 and (*b*) 0.63% strengths for 10 and 11 days. respectively. Determination of the amounts of boracic acid in definite volumes of solution at the commencement and

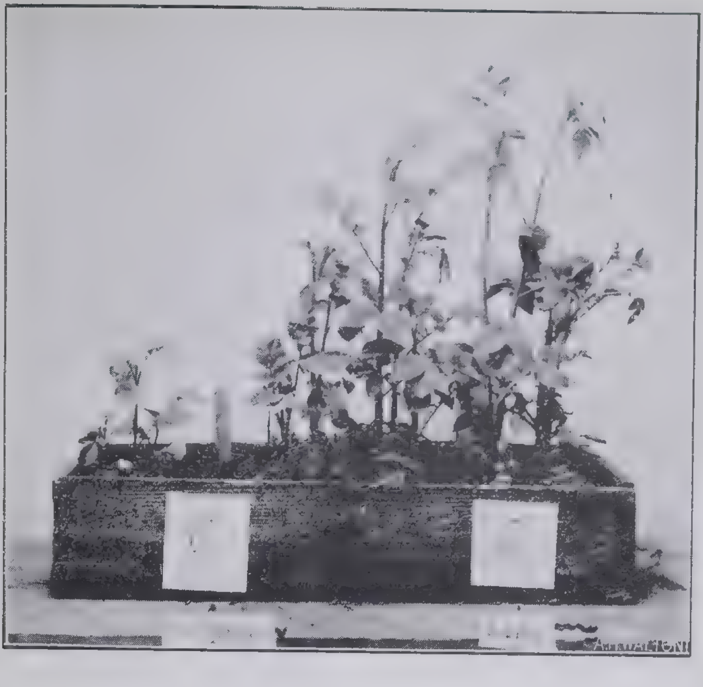

Fig. 11.

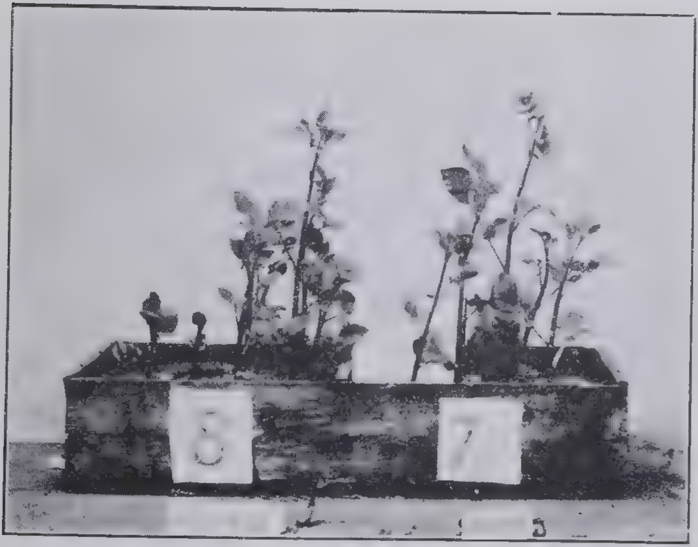

Fig. 12.
Illustrating influence on growth exercised by various treatments of "cut sets."

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termination of these experiments furnished the following results:

	Grams boracic acid per 100cc of solution.		
At commencement	1.61	......	0.63
At termination	1.60	......	0.65

The experimental evidence afforded by these steeping tests, in which tubers have been steeped either in a solution of salt or acid, shows that in none of these cases does the salt or acid used penetrate the tissue of the tuber in quantity.

Removal of the skin, on the contrary, as shown by the brine steeping experiments, and damage to the skin as the result of fungous invasion, as will be shortly shown, leads to the ready entry of sulphuric acid through the skin.

There exists, therefore, a mass of presumptive evidence for the view that one of the properties of the skin of the tuber is its impermeability to these various substances in solution.

No definite evidence, however, has yet been advanced with regard to the localisation of the points of entry of the dissolved substances—salts or acids—into the steeped tuber. Ordinary quantitative chemical determinations, as we have seen, measure with tolerable precision the march of the diffusion processes which occur when intact tubers are steeped in solutions of certain salts or acids, but furnish little information as to whether entry of these substances takes place through both skin and eyes or eyes alone. Before dealing with the steeping of tubers in sulphuric acid, and the localisation of the points of entry of the acid into the tuber, reference may be made to certain important structural differences between the skin, which forms the major portion of the external covering of the tuber, and the external layer in the region of the eye. This may be more readily followed by reference to Fig. 2, which diagrammatically represents a section through the "eye" of a tuber.

The layer indicated by the letters *cc*, and shaded by the vertical lines, is the corky skin of the tuber, *a* is the apex or growing point of the bud; bb_i, b_{ii}, b_{iii} are leaves. The figure shows that in the section under examination the skin terminates on either side of the bud abb_i. The point to be noted is that the external layer covering the apex, *a*, and its surrounding leaves, bb_i, consists simply of one layer of epidermal cells, the walls of which are not impregnated with *suberin*; that is to say, they are not of a corky nature. The enlarged drawings (Figs. 4, 5 and 6) illustrate this point, Fig. 6 representing the bud abb_i, Figures 4 and 5 showing the structure of the epidermal layer of the leaves *b*, b_i. There is then, structurally, a marked difference between the external layer of the eye of the tuber and that of the skin ; this differentiation extends also to the permeability of the two to substances in solution.

Sulphuric acid, it may at once be stated, under the conditions of experiment selected, diffuses into the tuber exclusively through the eyes, provided the skin of the object is intact, perfectly sound, and unruptured. The point is capable of precise demonstration.

If a freshly cut tuber, whether untreated or after steeping in water, be tested by placing a drop of a solution of methyl orange on the freshly exposed surface laid bare by cutting, the tissue reacts alkaline to this substance ; that is to say, the coloration produced is faint yellow. If a drop of the indicator (methyl orange) is added to a solution of sulphuric acid, the colorless acid solution acquires a pink colour. If now a tuber which has been steeped for five hours or longer in a 10% solution of sulphuric acid rendered intensely reddish pink by the addition of methyl orange, be examined, we may readily localise the points where the acid has entered by slicing the tuber, so that the plane of section includes an eye. Examination shows, assuming that the skin of the tuber was perfectly sound, that the eye (Fig. 7) and the immediately subjacent tissue for a few millimetres is more or less definitely mapped out by a faint but easily perceptible pinkish coloration. The areas in which this pink coloration is visible mark out those portions of the tissue into which the acid has penetrated, for since the tissue itself reacts alkaline to the indicator, ***i.e.***, gives a yellow colour, the occurrence of the pink colouration indicates the presence of the abosrbed acid. That the pink colouration is due to penetration of the acid may also be controlled by examining a tuber which has been steeped in a solution of methyl orange of similar strength to that used in the acid solution. If the tuber be sectioned and the plane of the section traverses an eye, no pink colouration will be visbile either there or elsewhere. As a matter of fact, the pink colouration, using methyl orange as indicator, is only given when acid and indicator have both entered the tissue. Examination of the sectioned tuber at points other than the eyes fails to reveal any pink colouration and the conclusion is therefore unavoidable that entry of the acid is confined to the eyes. We are therefore justified in concluding that the skin of the tuber is impermeable to sulphuric acid, and there are also good grounds for supposing that this also holds for boracic acid, and the various salts so far examined. The absorption of the various chemical substances then occurs almost, if not wholly, through the eyes of the tuber.

(*b*) Blight infested mature tubers.

Parasitic fungi, and notably that causative of Potato Blight (*Phytophthora infestans*) are particularly partly destructive to the skin of the tuber. In a tuber which has been attacked by Potato Blight the fungous organism remains in the form which has by convention been termed a hibernating mycelium; this consists of minute thread-like filaments which are usually resident in the more or less disorganised tissue immediately beneath depressions in the skin of the diseased tuber. These depressions, it is to be noted, are not always diagnostic of Potato Blight, and this is especially the case when mixed infection is present, or the appearances are complicated by the interaction of other factors, and also in cases of very slight infection. When Blight infected tubers are steeped in solutions of acid or salt the disorganised condition of the skin is revealed. The skin is apparently intact so far as it is possible to determine this point by the unaided vision, or the lower magnifying powers of the microscope. The steeping of such a tuber in a solution of sulphuric acid, or, better still, a solution of the acid deeply coloured by the addition of methyl orange, leads to results which strikingly demonstrate the altered character of those portions of the skin beneath which the seat of attack of the fungus is located. Instead of the entry of acid being confined, as in the case of blight free tubers, to the eyes, it now diffuses and with great rapidity through those parts of the skin beneath which fungal attack is in evidence (Fig. 8). Without actual demolition of the skin as a result possibly of the action of certain secretions of the attacking fungus, certain components of the walls which constitute the cells of the skin are profoundly altered or possibly destroyed. Whatever the actual nature of the changes may be, the nett result is clear: the previously impermeable skin is now rendered freely permeable to the various salts and acids which have been investigated.

Experiments with blight infected material showed that when mature tubers were steeped in 10% sulphuric acid for ten hours the vitality of both the tuber buds and the infesting fungus was destroyed. Repetition of these experiments, under rigid conditions of control, were invariably attended with results which were in no sense equivocal. The infected tubers after treatment invariably yielded negative results while untreated, but otherwise similar control tubers invariably gave positive results. That is to say, when treated and untreated, but otherwise similar tubers were placed under conditions favourable to the development of the fungus; in the former case no fructification was produced, while in the latter fructification invariably took place.

The effect such treatment might have on the storage qualities of practically blight-free tubers was also investigated. The fact was demonstrated, provided these were mature, and their skins intact, that if the period of storage was not inordinately prolonged and the conditions were dry and airy, neither the storage nor cooking qualities of the tuber were seriously impaired. It will be readily recognised from what has been stated in regard to the entry of sulphuric acid into the tuber, that the practical application of the acid treatment as a means of destroying the vitality of the buds depends in a great measure on the intact undamaged condition of the skin. At one period it appeared to be possible that the method would find application as a means of rendering tubers useless other than for consumption. The fact, however, that the material for further trial, representing for the most part tubers which had only recently been harvested, and comprising from 50 to 75% of tubers with damaged skins, rendered its application on a commercial scale impracticable.

This question of the ready permeability of the skin of the seed tuber, which has been ravaged by the attack of parasitic fungi, is not devoid of interest from the biological standpoint. The facts, unmasked, furnish a suggestive basis for the investigation of the possible means whereby adventitious infection from organisms in the soil may occur. These organisms, which may ordinarily function as saprophytes, but which through the ready means of ingress to the unprotected storage tissue of the tuber may play a disease producing role.

It is somewhat remarkable, as the result of the examination of a large number of such tubers, that there is little evidence of the possession of a capacity to form a protective covering of wound cork, which, as we have seen, is an invariable attribute of the healthy tuber. The subject is one which cannot well be pursued further, but must await a sufficiency of experimental evidence ; it is, nevertheless, as it stands, one for the practical grower's consideration.

In this paper an effort has been made to describe the more salient characters and functions of the skin of the potato tuber from the various points of view enumerated, namely, its structure, its protective and impermeable nature, and its biological significance.

The treatment of these various topics must not be regarded as having been dealt with finitely. In Economic Botany are many problems the solution of which essentially rests on the advances made in Plant Physiology and Plant Pathology. These departments of knowledge are largely interdependent, and are gradually becoming more so as time advances. The horizon of research is becoming still further widened by the accession of that branch of knowledge of comparatively modern origin which results from the fusion of Biology and Chemistry, namely, Biological Chemistry, without which the elucidation of the life activities of plant organisms cannot be regarded as other than incomplete.

SUMMARY.

The general conclusions to be derived from the experimental results here presented may be briefly enumerated as follows :—

1. The skin of the cultivated tuber is a structural covering, the walls of its component cells being of a corky nature. Its structure and the disposition of its layers indicate its protective function.

2. The results of physiological and biochemical investigation show that it is eminently protective against excessive losses of moisture and stored nutrient substances of the tuber.

3. The skin of the mature undamaged tuber is impermeable (under ordinary circumstances) to various salts and acids in solution. This impermeability is not possessed by blight-infected tubers.

4. Biologically the skin of the tuber is of considerable importance in offering a barrier to fungous and bacterial invasion.

HISTORY OF THE PERTH OBSERVATORY. By W. E. COOKE, M.A., F.R.A.S. (Read May 29th, 1912.)

The advisability of taking meteorological observations was first officially recognised in 1876, when a meteorological branch was added to the Surveyor-General of the department and readings of the barometer, temperature, etc., were commenced under the direction of the late Sir Malcolm Fraser. In the following year Mr. M. A. C. Fraser was appointed Observer, and continued to hold that office until February, 1896, when it was decided to establish an Astronomical Observatory and to transfer the charge of the meteorological department thereto.

Meanwhile the system had been extended by placing instruments in the hands of the postal officials in country towns, and at the end of 1895 there were fifteen of these contributing regular returns. After the establishment of the Observatory this branch was reorganised and extended. Regular inspections were made, and daily bulletins and forecasts issued. Steady growth and progress was made, and on January 1st, 1908, the Federal Weather Bureau was created and all the State services transferred thereto.

Coming back now to 1896, plans of the Observatory were prepared by the Public Works Department and the foundation stone laid in November of that year. It may be interesting to record that amongst a few odds and ends which were placed beneath that stone is one of the very first X-ray tubes, the science of radiography having only just started.

The main equipment of the Observatory consisted of two instruments, viz., a six-inch transit circle, by Simms, and an astrograph of the standard pattern, by Grubb. This latter had two telescopes, mounted equatorially, with parallel tubes. The object glass of the photographic telescope is thirteen inches in diameter, and of the guide telescope ten. All the work of the Observatory revolves round these two instruments, and all other equipment such as clocks, chronographs, etc., is subservient thereto.

Whilst the instruments were being erected and adjusted, and before a definite programme of work had been arranged, a letter was received by the Western Australian Government from the Permanent Committee of the International Astrographic Congress, asking the Perth Observatory to co-operate in the great star-cataloguing and charting scheme then in progress. As the geographical position and equipment of the Perth Observatory were exactly suited to such work, an affirmative reply was given and the zone of 32°-40° south declination was definitely assigned to our Institution.

This work, which up to now has constituted our main contribution to science, is divided between the two instruments in the following manner.

With the astrograph photographs covering the region assigned to us are being taken. Each plate contains an area of two degrees square, and successive plates overlap so that the edge of one corresponds to the central line of the next. Sufficient exposure is given to secure every object in the sky down to the 11th magnitude. In the Milky Way there are sometimes as many as 2,000 stars on a single plate, whereas in other portions of the sky there are less than 100. These are all measured and the positions referred to two straight lines on each plate as axes of co-ordinates. These measures, of course, only give *relative* positions, subject to various errors due to incorrect orientation and scale values. In order to obtain the absolute places in the sky we must know the positions of, say, twelve standard stars on each plate. These are determined by means of the Transit Circle. There are thus two main parallel lines of work going on. The rectangular co-ordinates of all stars in the assigned region down to the 11th Magnitude are being measured from the photographs, and the positions of about ten thousand selected stars are being rigorously determined by means of the transit circle.

An important part of the practical work of the Observatory is the distribution of standard time. The error of the sidereal clock is, of course, determined with the transit circle, and thence the standard time of the State is computed. This is distributed to the public in the following ways :—

(1) A time gun is fired daily in the Observatory grounds at 1 p.m. (12 noon on Saturday).

(2) A time ball is dropped daily at Fremantle at 1 p.m. and at such other hours as may be required for the benefit of shipping.

(3) A time gun is fired daily at 1 p.m. at Fremantle.

(4) Several time balls or semaphores are dropped at various hours in the city of Perth.

(5) An exact signal is sent at every hour to the chief operating room in the Perth telegraph office, which controls various clocks. Thence a signal is sent daily at noon to every telegraph office in the State.

(6) A similar control is effected in the central railway office, whence time is distributed daily to every State railway station.

(7) Arrangements are made whereby every telephone subscriber may at any moment obtain true time from the Exchange free of cost.

The error of drop of the Fremantle time ball is automatically recorded at the Observatory, and rarely exceeds 0.2 of a second. Amongst the minor instruments is a Milne seismograph, which records severe earthquakes in any portion of the world, and many local ones (*i.e.*, within 1000 miles or so) of small intensity.

"Visitors' evenings" have always been a popular feature—to such an extent that it has been found necessary to purchase a new instrument to meet the demand. A fine 12½-inch reflector, by Calver, mounted equatorially, with clockwork, has recently been erected near the main entrance, and a series of regular bi-weekly receptions instituted (with many others in addition). The telescope-house can be moved away on rails, leaving the instrument freely exposed in an open enclosure, with a high close fence for a wind-shelter. A lantern, screen, and specially selected set of slides, field and opera glasses, are also available, and it is endeavoured to make these evening receptions not only interesting but also educational. If the Government consent, it is proposed to extend this feature by occasionally taking the telescope to the Goldfields and giving lectures at various country towns.

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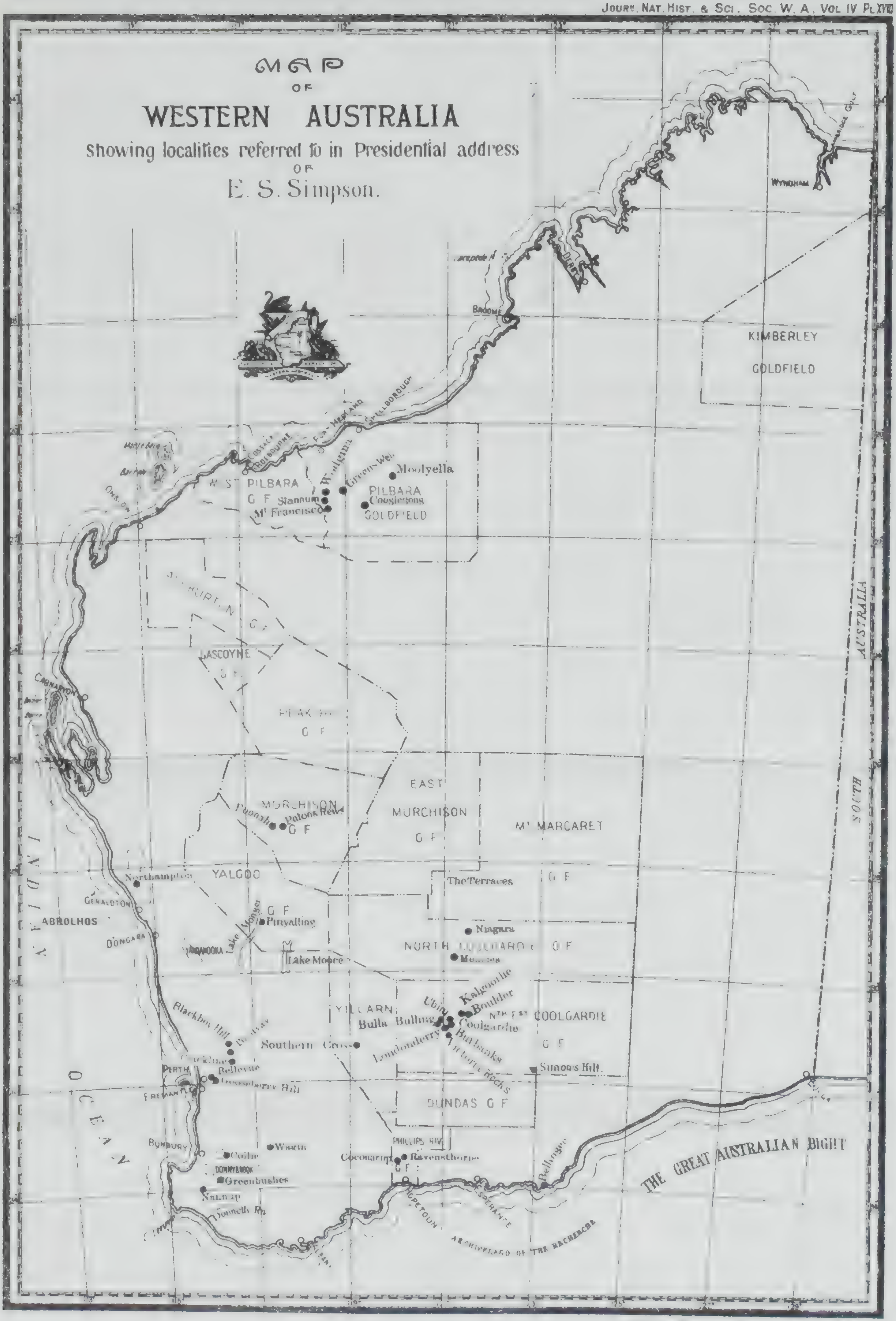
MAP
OF
WESTERN AUSTRALIA
Showing localities referred to in Presidential address
OF
E. S. Simpson.



[illegible] Government Lithographer [illegible]

THE RARE METALS AND THEIR DISTRIBUTION IN WESTERN AUSTRALIA. BY EDWARD S. SIMPSON, B.E., F.C.S., BEING THE ANNIVERSARY ADDRESS OF THE PRESIDENT, SESSION 1911-12. (Delivered June 11th, 1912.)

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INTRODUCTION.

What does the term "Rare Metal" mean? It is a term frequently employed, yet no authoritative and satisfactory definition is to be obtained. Further, cases are not infrequent where a "rare metal" of one generation becomes a common or moderately common metal of the next. What then is a practical criterion of a "rare metal"?

The latest (1912) international list of elements contains no less than 61 metals out of a total of 82 elements, yet of these 61 how few are really common metals. Perhaps if we seek first to define a common metal we may then consider all those which do not come under this category as coming under the complementary one of "rare metals."

Let us then tentatively define a common metal as one which forms a quite appreciable proportion of the whole earth's crust, say at least one part in 1,000. According to Clarke* there are only seven such, viz. :—

Aluminium	7.34	per cent.
Iron	4.11	,,
Calcium	3.19	,,
Magnesium	2.24	,,
Sodium	2.33	,,
Potassium	2.28	,,
Titanium	0.37	,,

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* F. W. Clarke: Data of Geochemistry.

It is evident, however, that there are more "common metals" than these, and that therefore our first tentative definition is not sufficiently elastic. Continuing on the same lines, if we extend the above definition to include those metals which form at least one part in 5,000 of the earth's crust*, we add to the above list only five more, viz. :—

Barium	0.09 per cent.
Manganese	.07 ,,
Chromium	.04 ,,
Strontium	.03 ,,
Nickel	.02 ,,

Our list of common metals grows but slowly, and we have not yet netted such obviously common metals as copper and lead. A further definition is necessary. Let us then extend it on other lines, thus :—

> "A common metal is one which forms an appreciable proportion, arbitrarily one in 5,000, of the whole earth's crust, or which enters into commerce and finds industrial application in notable quantities, arbitrarily at least some hundreds of tons in each year."

Our list of common metals is now increased to 23, the new additions being :—

	Approximate World's Production in 1910. Tons.
Lead	1,100,000
Zinc	1,000,000
Copper	800,000
Tin	104,000
Antimony	20,000
Silver	7,000
Mercury	3,500
Tungsten	2,500
Gold	700
Bismuth	500
Cobalt.............	400

The list of common metals is now satisfactorily complete, and we are left with no less than 38 metals out of a total of 61 which are entitled to the name "rare metal," in that they do not form an appreciable proportion of the earth's crust, nor do they enter into commerce and find industrial application in notable quantities. The full list of these metals is given in the accompanying table.

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* This is the limit of our knowledge owing to imperfect methods of determination, and lack of systematic search.

Table I.

Rare metals, with dates of discovery and name of discoverer.

Group.	Metal.	Date.	Name.
A	Lithium	1817	Arfvedson
	Rubidium	1861	Bunsen and Kirchhoff
	Caesium	1860	Bunsen and Kirchhoff
B	Radium	1899	Prof. and Mme. Curie
C	Beryllium	1797	Vauquelin
	Cadmium	1817	Stromeyer
D	Gallium	1875	de Boisbaudran
	Indium	1863	Reich and Richter
	Thallium	1861	Crookes
E	Yttrium	1794	Gadolin
	Scandium	1879	Nilsen
	Samarium	1879	de Boisbaudran
	Europium	1901	Demarcay
	Gadolinium	1886	Marignac and de Boisbaudran
	Terbium	1843	Mosander
	Dysprosium	1886	de Boisbaudran
	Erbium	1843	Mosander
	Thulium	1880	Cleve
	Ytterbium	1878	Marignac
	Lutecium	1907	Urbain: Welsbach
F	Cerium	1803	Klaproth: Berzelius and Hisinger
	Lanthanum	1839	Mosander
	Neodymium	1841	Mosander
		(1885	Welsbach)
	Praseodymium	1885	Welsbach
G	Zirconium	1788	Klaproth
	Thorium	1828	Berzelius
	Germanium	1886	Winkler
H	Vanadium	1801	del Rio
	Niobium	1801	Hatchett
	Tantalum	1802	Ekeberg
I	Molybdenum	1778	Scheele
	Uranium	1789	Klaproth
J	Ruthenium	1844	Claus
	Rhodium	1804	Wollaston
	Palladium	1803	Wollaston
	Osmium	1803	Tennant
	Iridium	1803	Tennant
	Platinum	? 1558	Scaliger
		1750	Brownrigg

There is a great range in the chemical and physical properties of the rare metals, practically every known group of the metals including at least one rare member. Individually and collectively they are a most fascinating company. The most positive (basic) metal known, viz., caesium, appears in the list, as also several of the least basic, such as niobium ; the heaviest metal, osmium*, and the lightest, lithium,†, are here ; the most noble metals, iridium, rhodium and ruthenium, and those most easily affected by chemical agents, caesium and rubidium. The most fusible of all metals, except mercury, are "rare," viz., caesium and gallium ; the most infusible, tungsten, has only recently been removed from the ranks of the rare metals, which still, however, number amongst them several which can only be melted in an electric arc, and also a metal, beryllium, which is not known to liquefy, but which passes direct from the solid state into the gaseous.

GENERAL DISTRIBUTION OF THE RARE METALS.

Little is known of the extra-terrestrial distribution of these elements, but what little is known points to their being rare not only terrestrially but also cosmically. This is a fact of deep significance. Our only means of recognising any elements beyond the confines of the earth are, first, the spectroscopic study of the light emitted by self-luminous heavenly bodies, and, secondly, the analysis by various means of those extra-terrestrial bodies, meteorites, which at rare intervals fall onto the earth's surface.

No less than fifteen rare metals have been detected with certainty in the sun.‡ They are :—

Beryllium
Scandium
Lanthanum
Germanium
Molybdenum
Cadmium
Erbium
Neodymium
Vanadium
Rhodium
Yttrium
Cerium
Zirconium
Niobium
Palladium

Eight others are of doubtful occurrence, viz. :—

Lithium
Uranium
Iridium
Thorium
Ruthenium
Platinum
Tantalum
Osmium

Cadmium has been reported in the star Alpha Cygni§, and in the nebula in Orion ; thallium in the Great Comet of 1882‖ ; vanadium in Arcturus¶.

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* Specific gravity, 22.4.

† Specific gravity, 0.59.

‡ J. Landauer : Spectrum Analysis, p. 200.

§ N. Lockyer : The Meteoritic Hypothesis, pp. 287, 396.

‖ Ibid., p. 222.

¶ W. S. Adams : Astrophys Jour. XXXIII.

In meteorites the following have been detected by spectroscopic and other means* :—

Lithium	Gallium	Vanadium
Palladium	Iridium	Platinum

J. C. H. Mingaye has proved the presence of the last three noble metals in the Mount Dyrring (N.S.W.) meteorite, and of platinum and iridium also in the Barraba and Cowra meteoric irons.†

The general discussion of the terrestrial distribution of a number of metals of such widely different characters is naturally not a simple matter, particularly in the present imperfect state of our knowledge. Only as interest in these rare metals and in their possible commercial value increases, and as fresh means of detecting and estimating them are worked out, will our shortcomings in this respect be overcome. A few broad generalities may, however, be stated :

(1) With the exception of platinum and the platinoid metals, and tantalum, none of the rare metals occur in the metallic state in nature.

(2) Whilst ordinary orthoclase or microcline pegmatite veins are as a rule devoid of rare metal compounds, the albite pegmatites associated with soda granites and syenites are invariably found to harbour them, usually in notable quantities and in great variety. Such pegmatities are the typical homes of the rarer alkali metals and the rare earth metals of the cerium and yttrium type, as well as tantalum niobium, beryllium and uranium. Tin ore is frequently found in such veins and in general, however occurring, tin ores are likely indicators of the presence of such rare metals.

(3) The rare noble metals of the platinum group are invariably associated with rocks of a highly basic character.

(4) Cadmium and the rare metals of the gallium subgroup are known mainly in association with metallic sulphides, particularly those carrying zinc.

Remarks on the general distribution of individual rare metals will be given later.

THE RARE METALS IN WEST AUSTRALIA.

Lithium - This is one of the least rare of the rare metals, and, being an essential constituent of several characteristic minerals, and yielding a simple flame test, is one whose presence is soon recognised. The existence of the element was first recognised by Arfvedson in 1817, but it was not till 1855 that it was obtained in metallic form by Bunsen and Matthieson.

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* L. Fletcher : Introduction to the Study of Meteorites.

† J. C. H. Mingaye : Records Geol. Surv. N.S.W., VII, 307, 310, 311.

Lithium minerals are almost invariably associated with granitic rocks and are concentrated in the pegmatite veins associated with them. They are frequently accompanied by tin ore. The commonest lithia mineral is lepidolite (lithia mica). Zinnwaldite (lithia-iron mica), spodumene (lithia jade) and amblygonite (a fluophosphate of lithium and aluminium) are less common minerals comparatively rich in lithium. Smaller quantities of lithium occur in other micas, and in some varieties of tourmaline, as well as in several rarer minerals. Lithium is detectable in traces in most granites, the average quantity present being about one part in ten thousand, or, in other words, about three ounces to the ton of rock. It is also present in minute quantities in almost all natural waters.

Of these minerals the following are found in the State :—

Lepidolite.—Wodgina, Stannum, Poonah, Ubini, Londonderry, Cocanarup, Ravensthorpe.

Spodumene.—Ravensthorpe.

Amblygonite.—Ubini, Ravensthorpe.

Lithia Tourmaline.—Ravensthorpe, Simon's Hill, Greenbushes.

Lithia Biotite.—Ubini.*

The proportions of the metal present in these minerals are naturally very variable, the few exact figures available being shown in Table II.

Lithium minerals in this State are found almost if not quite entirely round the outskirts of intrusive granite masses, where they are concentrated in pegmatite veins usually in association with large quantities of soda felspar (albite) and at times with ores of tin and tantalum.

Metallic lithium has no practical application at present, but some of its compounds are commercial products, being used in medicine, in the aerated water trade, and in charging Edison's latest storage battery. So far as our information goes, Western Australia is well endowed with lihtium minerals and could supply the market with them in case of present sources of supply becoming depleted.

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* E. S. Simpson: "A Peculiar Biotite (Anomite) from Ubini." Geol. Surv. W.A. Bulletin 48.

Table II.

Composition of Lithium Minerals occurring in Western Australia.

Mineral.	Amblygonite Large crystalline mass.	Spodumene. Large crystal.	Lepidolite. Large sheet.	Lepidolite. Small radiating sheets.	Lepidolite. Small radiating sheets.	Lepidolite. Small sheets.	Biotite. Spheroidal concentric sheets.
Locality.	Amblygonite Mine, Ubini.	Heads Smelter, Ravensthorpe.	Mica Mine, Londonderry.	Cocanarup.	Fraser's Tin Find, Londonderry.	Heads Smelter, Ravensthorpe.	Amblygonite Mine, Ubini.
Colour.	White.	Apple green.	Amethyst.	Pearl gray.	Vloiet.	Rose pink.	Dark re-dbrown.
Lithia, Li_2O	9.31	7.02	5.83	2.60	2.05	3.07	1.13
Soda, Na_2O	.78	1.93	1.03	.64	.82	2.63	.68
Potash, K_2O	none	.47	11.18	10.94	10.66	10.57	10.42
Alumina, Al_2O_3	34.71	26.48	23.22	29.01	30.67	27.40	26.96
Silica, SiO_2	none	61.94	51.67	47.58	45.19	48.78	43.12
Phosphoric oxide, P_2O_5	48.01	none	none	none	none	none	none

Caesium and Rubidium — These two very rare metals are closely related to lithium, with which they are usually associated in nature. Rubidium is not known as an essential constituent of any mineral species, and caesium only of two, viz., Pollucite (silicate of caesium and aluminium) and Worobiewite (caesium-beryl). Traces of both metals are of frequent occurrence in lithia-micas and other lithia minerals. They are concentrated in granitic extrusions. According to Vernadsky* "Caesium and rubidium withdraw from the magmas into the pegmatite veins in the aluminous silicates."

Neither metal has as yet been detected in this State. They are, however, to be expected in the lithium minerals already described and in beryl, which has been recorded from several localities, *vide infra.*

Beryllium -This somewhat rare metal was first detected by Vauquelin in 1797, though it was not till a generation later that it was separated in the metallic state, similar in appearance, weight and many chemical and physical properties to aluminium. Neither the metal nor its compounds have any practical applications.

It is an essential constituent of a number of minerals of which the best known is beryl (silicate of beryllium and aluminium), a mineral recorded up to the present from three localities in this State, viz., Ravensthorpe, Poonah and Greenbushes. At Ravensthorpe large pale yellow crystals are somewhat plentiful in an albitic pegmatite vein. Several greenish crystals have been met with in tin wash at Poonah, whilst a single small crystal is recorded from a tin lode at Greenbushes. No determinations have been made of the proportions of beryllium present in these minerals, but 11 to 15% of the oxide, or 4 to 5% of the metal, is the average content of this mineral.

A much less common mineral, Gadolinite (silicate of beryllium, iron and yttrium) occurs at Cooglegong and in the Lake Moore district. The composition of the Cooglegong mineral is given below.† It occurs in water-worn pebbles and *in situ* in a pegmatite vein :—

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* W. J. Vernadsky : On Worobiewite and the Chemical Composition of Beryl. Trans. Musée Geol. Pierre le Grand, 1908, 11, 81.

† B. F. Davis : Jour. Roy. Soc. N.S.W., XXXVI, 286.

Gadolinite, Cooglegong.

SiO_2	23.33	
BeO	10.38	(=3.76 Be)
FeO	12.28	
Ce_2O_3	2.50	
$La_2O_3 + Di_2O_3$	18.30	
$Y_2O_3 + Er_2O_3$	33.40	
MgO	.69	
Ignition loss	.32	
	101.20	
Sp. Gr.	4.14	

Cadmium.—This metal belongs to the same group as beryllium. Whilst it is probably if anything less common than thatmetal and is only found in large proportions in a single very rare mineral, greenockite (cadmium sulphide). It, on the other hand, is an invariable constituent of zinc ores in quantities ranging from traces up to 3 per cent. During the smelting of zinc ores for the metal, cadmium is readily obtained as a bye-product and for many years now has been put to practical use. The metal is a constituent of many fusible alloys, whilst compounds are used in photography, in electric cells, and in pigments. It was first detected as long ago as 1817 and shortly afterwards obtained in the metallic state.

Cadmium is present in appreciable quantities in the blendes of Northampton (W.A.) and probably exists in recognisable amounts in other zinc ores in the State.

Gallium, Indium, Thallium These three metals are closely related chemically and are all extremely rare. Thallium alone is known to form an essential constituent of two very rare minerals, Crookesite (selenide of copper, thallium and silver) with 16-19% Tl, and Lorandite (a sulpharsenide of thallium) with 59-60% Tl. In addition to these thallium has been detected in traces in certain specimens of native bismuth, blende, pyrites, chalcopyrite, lepidolite, phlogopite and zinnwaldite. Indium is known, only in traces, in a number of minerals of widely different types, including blende from many localities, most iron ores, zinnwaldite, manganotantalite and wolfram. Gallium is known as traces (up to 0.002%) in many blendes and bauxites, and has also been detected in zinnwaldite and phlogopite.

All three elements were discovered about fifty years ago and have since been prepared in the metallic state. They prove to be soft, white or gray, easily fused metals. No practical use has been found for any of them. One of the most remarkable properties of gallium is that whilst unoxidised by exposure to air it will melt readily if held in the hand, its fusion point is so low (30°C.). The only compound of any of these elements put to any practical use is the nitrate of thallium used for determining the specific gravity of gemstones and other minerals.

None of these metals has been recorded as yet from any mineral in this State, simply for lack of search. There is every reason to believe that they do exist here, merely awaiting careful search to be detected.

Yttrium Group of Metals.—Yttrium is a moderately common element, forming an essential constituent of many minerals, and also occurring in small quantities in a large number of others. It is invariably associated with small amounts of several other rare metals of similar character, viz.:—

Scandium
Samarium
Europium
Gadolinium
Terbium
Dysprosium
Erbium
Thulium
Ytterbium
Lutecium

As long ago as 1794 a new metallic oxide was separated by Gadolin and subsequently named yttria. This, however, was not true yttrium oxide, but a mixture of that oxide with much oxides of erbium, etc. It was not till 1843 that it was shown to contain the oxides of at least three metals—yttrium, erbium and terbium. During the last thirty years the further complexity of the original yttria has been shown, the latest new metal to be added to the list being Lutecium by Urbain and Welsbach, working independently, in 1907.

As already stated, yttrium is an essential constituent of many minerals of which gadolinite (silicate of yttrium, iron and beryllium), xenotime (phosphate of yttrium), euxenite (niobate, tantalate and titanate of yttrium, erbium and uranium), and fergusonite (tantalate and niobate of yttrium, erbium and uranium) have already been discovered in this State. Certain cerium minerals of local occurrence also contain small percentages of this metal.

Erbium oxide is known to form a considerable proportion (one-quarter to one-third) of the total rare earths in most yttrium minerals, including those in this State which have been examined in detail. It is known in other parts of the world as the main base of a single mineral, Sipylite.

None of the other metals of this group have been looked for in this State, though doubtless present in small amounts. Scandium in particular has of later years attracted much attention. It is known in quantity in but one mineral, viz., Thortveitite (a silicate of scandium). Our latest knowledge of the distribution of this metal as given by Vernadsky* may be summarised thus :—

> "Scandium occurs principally in the following minerals: Zirconium-minerals, beryl, titanates, niobates and titanoniobates of the rare earths, cassiterite, wolfram and mica. These minerals belong to a definite natural group, viz., the minerals of the pegmatite veins and stock works of the acid rcoks of the granite and syenite type."

It is evident that Scandium should be widely distributed in this State where the typical minerals mentioned are widespread.

The yttrium metals in general are usually found both here and elsewhere concentrated round the periphery of intrusive granite in the pegmatite offshoots. Details of local occurrences are as follow :—

COOGLEGONG, *Gadolinite.*—In black masses in pegmatite and in rolled pebbles in stream gravel. $(Y,Er)_2O_3$, 33.40%. Analysis on page 91.

Euxenite in brown angular pebbles in alluvium. $(Y.Er)_2O_3$, 25.03%. Analysis given below, page 22. Full details of this occurrence are described in the Australasian Association Report for 1909, page 313.

Fergusonite, abundant in angular pebbles in alluvium. $(Y.Er)_2O_3$, 31.38%. Analysis below, page 22. For further details see Australasian Association Report for 1909, page 132.

Monazite, abundant in small angular and crystalline pebbles in alluvium. $(Y.Er)_2O_3$, 0.04%. See under Cerium, page 94.

MOOLYELLA.—*Monazite,* common in small angular and crystalline pebbles with stream tin ore. $(Y.Er)_2O_3$, 0.14%. See under Cerium, page 94.

LAKE MOORE DISTRICT.—*Gadolinite.* No details of this occurrence.

GREENBUSHES.—*Xenotime.* Occasional small octahedra associated with stream tin.

NANNUP.—*Xenotime.* Few small octahedra in concentrates from alluvium.

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* W. Vernadsky: "Notes on the Distribution of Scandium," Bull. de l'Acad. Imp. des Sciences, de S. Petersbourg, 1908, II, 1273-4.

Cerium Group of Metals—This group includes four rare metals, viz.:

Cerium	Neodymium
Lanthanum	Praseodymium.

Of these, so far as we know, cerium, the first to be discovered (1803), is the most abundant, praseodymium the least. None of the metals have any practical application and the only compounds in use are the oxide of cerium, which is used in small quantities in the Welsbach mantle, and the oxalate of cerium, which is used medicinally.

Cerium is suspected to be somewhat widely distributed in very small amounts as an original constituent of granites and allied rocks. Monazite, phosphate of cerium, etc., can usually be detected in the beds of streams draining granitic areas. Together with more or less of the other three metals of the group, cerium forms a large proportion of several minerals found in pegmatite veins, chief of which are monazite (phosphate of cerium, etc.), and allanite (silicate of iron, cerium, etc.), both of which are known to occur in this State. Details of these occurrences follow.

MOOLYELLA.* *Monazite.* Plentiful in alluvium in brown opaque pebbles ranging in weight from 0.05 to over 4.0 grammes, average about 0.15 gramme. The pebbles are often crystallised, but are mostly sub-angular or rounded The composition of this mineral is given below.

COOGLEGONG.*—Monazite occurs here in considerable amount and similar in every respect to the Moolyella monazite, but in larger fragments, up to 10 grammes, the average being about 0.6 gramme. Analysis given below. *Fergusonite, euxenite* and *gadolinite* containing a little cerium, etc., see pages 9, 22.

SHAW TINFIELD (near Cooglegong).—A little brown monazite in stream tin ore.

WODGINA. -Traces of cerium metals present in Mackintoshite, Thorogummite and Pilbarite. See page 106.

POONAH.—A few small fragments of monazite in stream tin ore.

FRASER RANGE. -A few masses of allanite have been received from this locality.

GREENBUSHES.—A few small fragments and crystals of monazite in stream tin ore and zircon sands, see page 16.

DONNELLY RIVER.—Small quantities of monazite sand in some of the tributaries of this river.

Most of the black sands of the South-West Division yield traces of monazite.

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* E. S. Simpson: "Further Occurrences of Tantalum and Niobium in Western Australia."

* G. S. W. A. Bull 48 :The Occurence of Monazite at Cooglegong and Moolyella.

TABLE III.

Analyses of Monazite, Western Australia.

Locality. Nature of Sample.	Moolyella. 40 pebbles.	Moolyella. 5 pebbles.	Moolyella. 28 pebbles.	Moolyella. Small bulk sample.	Cooglegong. Single crystal.	Cooglegong. Large bulk sample.
Ce_2O_3	33.06	65.41	65.34	61.31	31.10	53.19
$La_2O_3 + Nd_2O_3 + Pr_2O_3$ ...	30.21				34.26	
Y_2O_3	.14				.04	
ThO_2	5.03	5.17	5.24	5.02	3.80	4.38
UO_2	none				str. trace	
Fe_2O_3	2.21				.42	
Al_2O_3	.44				.64	
CaO	.90				.34	
MgO	.21				trace	
PbO................	trace				trace	
P_2O_5	26.70				26.89	
SiO_2	1.22				1.96	
H_2O+	.59				.58	
	100.71				100.03	

For complete details see "The Occurrence of Monazite at Cooglegong and Moolyella," by E. S. Simpson, Bulletin 48, Geol. Sury of W.A.

Thorium—This metal was discovered as long ago as 1828 by Berzelius, but was merely of scientific interest up till the invention of the incandescent mantle by Welsbach. This latter is composed almost entirely of thorium oxide, for which reason thorium minerals are in keen demand at the present day. In its metallic form, thorium has no applications.

Thorium, like many other metals, is found chiefly in pegmatite offshoots from granite or syenite intrusions. It is found under a variety of circumstances, viz.: —

(*a*) As the chief metallic constituent of a mineral, such as thorianite (oxide of thorium) and thorite (silicate of thorium). No such mineral is yet known in W.A.

(*b*) Forming with uranium the chief metal in a mineral such as thoriferous pitchblende, mackintoshite, thorogummite, pilbarite, the last three of which occur in this State.

(*c*) In small and inessential but often commercially important proportions in cerium and yttrium minerals, especially monazite, which is the chief source of the industrial supply. Several such minerals are of local occurrence.

The known sources of thorium in this State are:—

MOOLYELLA.—Monazite from this locality has yielded 5.03, 5.17, 5.24 and 5.02% ThO_2. See page 95.

COOGLEGONG.—Monazite contains 3.80 and 4.38% ThO_2. Fergusonite carries 1.02% ThO_2; euxenite, 1.76% ThO_2. See pages 13, 22.

WODGINA.—Three minerals rich in thorium occur here, viz., Mackintoshite, 24.72% ThO_2; Thorogummite, 24.46% ThO_2; Pilbarite, 31.34% ThO_2. For details see pages 25, 26.

GREENBUSHES.—Zircon sand carrying trace ThO_2. See page 97.

The other cerium minerals mentioned on page 95 also undoubtedly carry thorium, though no analysis of them is available.

Zirconium—This is one of the least rare of the rare metals and one of the first to be discovered (Klaproth, 1788). The oxide zirconia is stated by Clarke to form three parts in every ten thousand of the solid crust of the earth.* It is an important constituent of one very widely distributed mineral, zircon, and of many much rarer minerals. It is not known in nature in the metallic state. Zircon is present in all igneous rocks, particularly in granites and syenites. Being very resistant to atmospheric attack, it is detectable in most clays and sands and usually forms an appreciable percentageof titaniferous iron sands and other heavy sands.

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* F. W. Clarke: Data of Geochemistry.

Metallic zirconium has been prepared but not put to any practical use except as an alloy with tungsten. The oxide is used for a great variety of purposes; it is, for instance, the chief constituent of the glower of the Nernst lamp, enters into the composition of certain glasses and enamels, is used in Rontgen-therapy, and as refractory material in electric furnace linings, etc.[†]

Zircon has been proved by both microscopic and chemical means to be present in many crystalline rocks in this State. It can be detected in small well-formed colorless or smoky crystals by panning off any of our clays (*e.g.*, Bellevue, Belmont, Mujar) or river or beach sands, especially those sands which show by the presence of black iron compounds that they have been naturally concentrated. Examples of the latter kind are:—

South Perth.—Black sand, estuary beach.

Cottesloe.—White and black sand, sea beach.

Koombana Bay.—Black sand, sea beach.

Nannup.—With cassiterite in river sand.

Greenbushes.—With cassiterite in alluvium of all kinds.

Gooseberry Hill.—Black and white sand, stream.

Donnelly River.—Forms large proportion and at times the whole of the concentrates from river sand.

At Greenbushes zircon sand could be produced in commercial quantities as a by-product in tin sluicing. A bulk sample of about 30 lbs. weight of such sand was found to have the following composition:—

Zircon sand, Greenbushes.

ZrO_2	47.63 (Zr, 35.2%)
ThO_2	trace
TiO_2	17.12
SnO_2	2.83
SiO_2	23.84
Ce_2O_3	.84
Fe_2O_3	6.30
P_2O_5	.83
Undetermined	.61
	100.00

[†] C. R. Bohn, Chem. Zeitung, XXXV, 1261.

From this analysis and from microscopical examination the following mineral composition has been calculated :—

Zircon .... about	71%
Rutile	11
Ilmenite	12
Cassiterite	3
Monazite	1
Cyanite	traces
Gahnite	,,
Magnetite	,,
Apatite	,,

Germanium—This very rare metal was first recognised in 1886 by Winkler, and has since been prepared in metallic form in light grey lustrous crystals. It is an essential constituent of one mineral, argyrodite, a sulphide of silver and germanium. Small proportions occur in Canfieldite, another silver ore, whilst traces have been detected in Euxenite and other tantalum minerals.

Our present interest in this metal lies in the fact that, according to my friend Mr. W. B. Giles, F.I.C., a chemist with considerable experience of the rare metals, germanium occurs in quite appreciable quantities in the Stibiotantalite from Greenbushes.

Vanadium.—Vanadium, first discovered in Mexican ores by del Rio in 1801, is one of the few rare metals the presence of which in rocks or minerals in as small proportion as one part in ten thousand can readily be detected with the help of the simplest apparatus. Largely because of this fact it is known to be widespread in small quantities. Clarke* estimates that it forms about one part in every five thousand of the whole earth's crust, but this figure is a rough approximation only. In addition to this wide distribution in small quantities in most rock masses, the metal is concentrated in larger proportion in certain characteristic minerals which form the source of the world's supply of the metal and its compounds. The most important of these minerals are Carnotite (vanadate and uranate of potash) and Vanadinite (chlorovanadate of lead). Other less common minerals are Roscoelite, a vanadium mica, and Pucherite, a vanadate of bismuth, both of which are recorded from Western Australia.

The chief commercial use for vanadium is an addition in small amounts to steel for certain purposes, particularly springs, saws, motor car parts, etc. Several compounds are used in small quantities.

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* Data of Geochemistry.

In Western Australia, vanadium has already been proved to be widespread in small quantities, particularly in the ancient greenstones, in the laterites, in the clays, and in coal ashes. In the two first named the proportion present is often far above the average given by Clarke. In many of these the exact proportion has been determined by the usual analytical methods with the following results :—

Laterites.

Turgite laterite, Kalgoorlie (1)	V_2O_5 %	0.40
,, ,, ,, (2)		0.45
,, ,, ,, (3)		0.65
Limonite laterite, Kalgoorlie......		0.15
Turgite laterite, Coolgardie		0.55
Bauxite laterite, Gooseberry Hill ..		0.23

Greenstones and Allied Rocks.

Diabase—Mt. Holmes	V_2O_3 %	0.09
Gabbro—Boulder, Kalgoorlie		0.06
Amphibolite, Mt. Hunt		0.04
,, Kalgoorlie		0.10
Quartz Epidiorite, Boulder		0.25
Epidiorite—Boulder		0.08
Propylite, Kalgoorlie		0.30
,, Boulder		0.04
Carbonated Amphibolite—Boulder		0.33

Ores.

Greenstone schists—Boulder	V_2O_3 %	0.11, 0.06, 0.12, 0.32.
,, ,, Kalgoorlie		0.32, 1.21.

Traces of vanadium in clays are disclosed by the yellow or green efflorescence of vanadium compounds of potash on the surface of a brick which has for the first time been wetted and then slowly dried. In the laboratory the presence of the same compounds is shown by the bright yellow colour of water which has been made to slowly percolate through a trial briquette burnt at a temperature not exceeding 1,050° C. or thereabouts. In one or other of these ways vanadium has been detected in the following :—

Albany—Brickearth (an estuarine silt), 4 miles north of town.
Clackline—Fireclay, a granite decomposed *in situ*.
Bellevue—Red brick earths, talus and flood earths.
Belmont—Brown brick and tile clay, sedimentary.
Collie—Brown surface clay.

The ashes from Collie coal contain appreciable amounts of vanadium, the following figures being available :—

Seam.	Proprietary.	Co operative No. 2.	Cardiff No. 1.	Cardiff No. 2.	Collieburn No. 1.
V_2O_5 %	0.21	0.10	0.07	0.05	0.02
			0.04		trace

Several minerals, of which vanadium is an essential constituent, are known in Western Australia, viz. :—

Roscoelite (vanadium mica) and an undescribed chrome-vanadium mica are moderately plentiful in the gold ores at Kalgoorlie and account for the relatively high proportions of vanadium shown in analyses of these ores. An analysis has been published of this mineral, *vide infra.*

Pucherite (vanadate of bismuth) in small crystals is found in the concentrates from a gold mine at Niagara.* (North Coolgardie). Analysis below.

Vanadinite (chlorovanadate of lead) has been detected in small yellow crystalline crusts in fractures and vughs in auriferous quartz from Burbanks, Coolgardie, Menzies, Pinyalling, and elsewhere.

Vanadium minerals, W.A.

	Pucherite Niagara.	Rosc elite Kalgoorlie.†
SiO_2	.81	43.65
V_2O_3	—	27.11
V_2O_5	25.31	—
P_2O_5	trace	—
Al_2O_3	—	9.95
Fe_2O_3	.36	not det.
Bi_2O_3	73.77	—
CaO	—	1.43
MgO	—	1.51
Alkalis	—	not det.
	100.25	83.65

Tantalum and Niobium—Owing to their wide and comparatively plentiful distribution in this State, these two closely-related metals are of special interest to us. Like many other rare metals, they are invariably found in association in offshoots from masses of intrusive granite or syenite. Metallic tantalum has recently been recorded in traces from Siberia, but the only important sources of the metals are the compounds of tantalic and niobic acid with iron, manganese and lime.

Quite recently the practical utilisation of tantalum in metallic filaments for electric lights and its experimental application in other directions, either in the pure state or as an alloy of steel, have led to a careful search for this metal throughout the world. So far no use has been found for niobium.

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* E. Griffiths, " Note on Pucherite from West Australia." Jour. Roy. Soc. N.S.W., Vol. XLII, 251.

† Pearse, Bull. Colorado Sci. Soc. No. 8, 1897.

Many details of the occurrence of these metals in the State have already been published by the author,* so that only a brief recapitulation will be attempted here, together with a few notes on more recent discoveries. In brief, it may be said that tantalum minerals containing also niobium have been found over a large area extending from the North-West to the South Coast, usually in association with tin ore; in fact, hardly a sample of alluvial tin concentrates produced in the State is free from them; some carry more tantalum than tin.

The following are brief particulars of known occurrences starting from the northern part of the State and working southwards:—

MOOLYELLA TINFIELD (Moolyella, Tadgebanna and Mud Springs). Manganocolumbite (niobate and tantalate of manganese) and at times a little manganotantalite (tantalate and niobate of manganese) present in all stream tin concentrates. Quantities actually recorded were 8.5, 13.5, 15.5, and 46.5 per cent.

COOGLEGONG AND ELEYS.—Fergusonite (tantalate and niobate of yttrium, erbium, etc.) appears to be somewhat plentiful in small detrital masses. An analysis is given below of a typical fragment. Profs. Wedekind and Maas, of the Strasburg University, have recommended this material as a good basis for the preparation of tantalum and its compounds on a commercial scale.† Alluvial euxenite (tantalate, niobate and titanate of yttrium, etc.), columbite and tantalite have also been recorded in small quantities from this district.

LALLA ROOKH (16 miles north of). Detrital columbite, mostly well crystallised, has been obtained here.

GREEN'S WELL.—Columbite and tantalite, much of it well crystallised, have been obtained from here in alluvium and in a pegmatite vein. A small parcel has been marketed. A little microlite (tantalate of lime) occurred in this parcel. See analyses below.

WODGINA.—Over 80 tons of high-grade tantalum ore (Mangano-tantalite) have been raised in this locality. It is found *in situ* in an albite pegmatite vein and as detrital masses on the slopes of the hills and in the stream beds, in the latter case with more or less tin ore. Mangano-columbite and ixiolite (stanno-tantalate of manganese) are also recorded from this centre. Analyses are given below.

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* "Tantalum and Niobium in Australia," Rept. Aust. Assoc. Adv. Sci., 1907. "Further Occurrences of Tantalum and Niobium in Western Australia," Rept. Aust. Assoc. Adv. Sci., 1909. "Tantalum (in W.A.)," Geol; Surv. W.A. Bull. 30. "Tantalite at Londonderry," An. Prog. Rept. of the G.S.W.A. for 1909, p. 27.

† Zeitschrift fur angew. Chemie, 1910, Heft 49, S. 2314.

MOUNT FRANCISCO. -Manganocolumbite is moderately plentiful here in an albite pegmatite and in alluvium.

POONAH.—Several fragments of detrital manganocolumbite weighing from 6 to 13 grammes have been picked out from steam tin ore. The specific gravity averaged 5.7 and the content in Ta_2O_5 varied from 17 to 25%, in Nb_2O_5 from 65 to 57%.

LAKE MONGER DISTRICT.—A few fragments (weighing from 12 to 43 grammes) of iron columbite have been received from here. Average assay Ta_2O_5, 20%; Nb_2O_5, 62%.

LONDONDERRY.—Two large fragments of supposed tin ore found by Frazer 3 miles west of the famous Londonderry gold mine, in 1909 proved to be manganotantalite carrying 49% Ta_2O_5 and 34% Nb_2O_5. Both of these fragments were well crystallised. Later many more small detrital fragments were obtained ranging in weight from 0.5 to 50 grammes. They were mostly manganotantalite or manganocolumbite in about equal proportions. Several crystalline fragments contained much tin oxide as well as tantalic oxide. These are probably ixiolite.

VICTORIA ROCKS.—Mr. Frazer, the veteran prospector, reports that tantalite occurs at this locality and at intervals between here and his Londonderry find.

BELLINGER. In a mica vein at this locality a little tantalum ore occurs ranging from ferro-tantalite to manganocolumbite in composition.

GREENBUSHES. High grade tantalite is moderately abundant in a greisen vein and in alluvium at the south end of this tinfield. Several tons have been raised for the market. The mineral rarely shows any trace of crystallisation. On splitting some lumps of this ore one finds thin fracture fillings and surface replacements of the tantalite by a yellow resinous crystalline mineral. This is stibiotantalite (tantalate and niobate of antimony), an extremely rare mineral first discovered in Greenbushes by our Hon. Treasurer (Mr. J. J. East), and only recently found at one other locality in the world. Stibiotantalite is also found in small quantities in the stream tin ore, as also is tantalite.

Tantalum also occurs at Greenbushes in small amounts in solid solution in the clean cassiterite. A crystal from the South Cornwall lode had the following composition :—

SnO_2	97.63%
Ta_2O_5	1.76
Fe_2O_3, etc.	.61
	100.00

TABLE IV. *(Analyses of Tantalum Minerals, Western Australia.)*

Mineral Locality.	Fergusonite. Cooglegong.	Euxenite. Cooglegong.	Microlite. Green's Well.	Mn-tantalite. Wodgina.	Ixiolite. Wodgina.	Tantalite. Greenbushes	Stibiotantalite. Greenbrushes.
Ta_2O_5	55.51	21.92	73.54	68.65	70.49	80.61	51.95
Nb_2O_5	2.15	5.53	3.62	15.11	7.63	2.50	4.49
SnO_2	none	none	.90	.48	8.92	1.51	—
TiO_2	2.20	29.95	—	.40	—	.71	—
ThO_2	1.02	1.76	—	—	—	—	—
SiO_2	—	—	—	—	—	—	3.14
WO_3	—	—	—	trace	—	.13	—
H_2O	3.36	2.82	1.28	.07	.18	.14	.61
FeO	trace	trace	3.64	1.63	1.34	10.89	—
Fe_2O_3	—	—	—	—	—	—	.39
MnO	.87	.34	.60	14.15	10.87	3.78	trace
NiO	—	—	—	trace	—	.02	trace
CuO	—	—	—	—	—	—	.20
CaO	2.18	1.02	13.46	trace	.42	none	—
MgO	—	.35	.42	.15	.37	.19	—
Sb_2O_3	—	—	—	—		—	38.04
Bi_2O_3	—	—	—		—	—	.79
Y_2O_3	23.00	15 76	—	none	—	none	—
Er_2O_3	8.38	9.27	—	—	—	—	—
Ce_2O_3	.94	1.82	—	none	—	none	—
La_2O_3, Di_2O_3	—	1.73	—	—	—	—	—
UO_3	1.18	6.69	—		—	—	—
Al_2O_3		.76	—	—	—	—	—
K_2O			.20		—	—	
Na_2O	—	—	1.66	—	—		
	100.79	99.72	99.32	100.64	100.22	100.48	99.61

Molybdenum—This was one of the earliest of the rare metals to be discovered (Scheele, 1778), principally because the pure sulphide of the metal, molybdenite, is a very characteristic mineral, occurring somewhat widely distributed in small quantities, usually in close association with granitic rocks. A few other much rarer minerals are known containing this metal as an essential constituent, whilst scheelite, a tungsten ore of commercial importance, contains molybdenum in proportions ranging from traces up to 6 per cent.

For some years past molybdenum has been used as a constituent of steel for tools, big guns, propeller shafts, etc. Quite recently the very pure metal has been produced in the form of ductile wire, which is already being used for winding electric furnaces, as supports in metallic filament lamps, etc. Ammonium molybdate is a salt of considerable commercial importance. Present indications point to a rapid increase in the use of metallic molybdenum and its consequent translation from the ranks of the rare metals to those of the commercially common metals.

With the immense areas of granite exposed in this State, molybdenum would be expected to be widespread. Already it has been detected in many localities, the list of which is being yearly added to. Details of its occurrence follow:—

NEAR PATON'S REWARD (Murchison G.F.).—Molybdenite in small and large masses in quartz stringers and adjacent granite, associated with wolfram and scheelite.

COOLGARDIE.—Molybdenite, a few small specimens embedded in amphibolite.

BULLABULLING.—Molybdenite moderately plentiful in small quartz leaders in granite.

THE TERRACES (Mt. Margaret G.F.) Small flakes of molybdenite plentiful in quartz leaders in granite.

SOUTHERN CROSS.—Molybdenite flakes and crystals in quartz veins.

TOODYAY.—Small masses of molybdenite plentiful in solid grey granite.

CLACKLINE.—Small flakes of molybdenite in quartz. At surface a little molybdic ochre

BLACKBOY HILL.—Small flakes of molybdenite in quartz.

WAGIN.—Small flakes of molybdenite in quartz.

BULDANIA.—Single specimen showing a mass of molybdenite in greenstone.

RAVENSTHORPE (near).—Flakes of molybdenite in quartz.

Scheelite is moderately abundant in the State, but none of it has ever been examined with a view to determining the possible presence of molybdenum in it.

Uranium and Radium—Uranium, one of the first of the rare metals to be discovered, and Radium, one of the latest, have no resemblance in chemical properties They are, however, conveniently considered together as in Nature they are invariably associated, usually in the ratio of one part by weight of radium to each three million parts by weight of uranium. The reason for this constant association proves to be that radium is one of the products of disintegration of uranium.

Metallic uranium is so far only of scientific interest. Compounds of it are in use in photography, analytical chemistry, enamelling and glass making. The chief demand for uranium compounds at present, however, is for the sake of their contained Radium.

Radium, the most interesting, most rare and most precious of all metals, has only been prepared in minute quantities as a scientific curiosity. Its compounds, however, particularly the bromide, are in strong demand for therapeutic and experimental purposes.

Uranium, with its accompanying traces of radium, is present in minute traces in all rocks and mineral waters. The commercial supply of the metals comes from several minerals carrying several parts per cent. of uranium, whose habitat is the pegmatite veins associated with intrusive granite or syenite. One important uranium mineral, Carnotite, is found in commercially important quantities in sandstone in Colorado. The best known and richest ore of Uranium is pitchblende or uraninite (oxide of uranium).

Neither pitchblende nor carnotite have been located as yet in W.A. The State, however, is not devoid of uranium ores, as the following notes show.

Known occurrences are :—

COOGLEGONG.—Detrital Fergusonite somewhat plentiful, carrying 1.18% UO_3, equal to 0.98% uranium, and about 3½ milligrams of radium per ton. Detrital euxenite rare, carrying 6.69% UO_3, equal to 5.57% uranium and about 2 centigrams of radium per ton. See also page 103.

WODGINA.—An important and interesting deposit of uranium ores occurs here in an albite pegmatite vein The minerals present are mackintoshite, thorogummite and pilbarite, all of them hydrous silicates of uranium, thorium and lead, of which analyses are appended. I had the honour on a previous occasion* to describe to you the discovery and occurrence of pilbarite, a new ochreous mineral occurring in the outcrop of the lode. At that time it was recognised that pilbarite was a surface alteration product of some as then unknown deep-seated mineral or minerals. The parent mineral, mackintoshite, and an intermediate product, thorogummite, have since been encountered at Wodgina, and a full description of them is now in the press.†

Briefly, the primary mineral, mackintoshite, is black, subvitreous and massive. It carries 35.60% UO_2 partly oxidised to UO_3 by incipient development of the intermediate mineral, thorogummite. The latter is bright yellow, vitreous and massive. It carries 37.33% of UO_3. The final product of weathering, pilbarite, is granular massive, bright yellow in colour, but with dull lustre. It carries 27.09% UO_3.

All three minerals contain radium in the following estimated proportions:—

Mackintoshite,	11	centigrams	per ton.
Thorogummite,	11	,,	,,
Pilbarite,	7	,,	,,

Such quantities of radium might well be expected to more than pay for the cost of extraction, even though the latter is complicated by the presence of so much thoria, which in its turn would form, with uranium oxide, a valuable by-product.

The composition of these minerals is as follow:—

Uranium Minerals, Wodgina.

UO_3	present	37.33	27.09
UO_2	35.60	none	none
ThO_2	24.72	24.46	31.34
Ce_2O_3	.10	.12	.19
Y_2O_3	.25	.32	.49
Al_2O_3	trace	trace	.15
Fe_2O_3	—	trace	.20
FeO	.20	—	—
PbO	7.90	7.78	17.26
CaO	1.28	1.62	.57
MgO	.15	.16	.21
MnO	.07	none	none
K_2O	—	—	.09

---

* See Jour. Nat. Hist. & Sci. Soc. of W.A., Vol. 3, No. 2, p. 13

† E. S. Simpson: "Radium-uranium Ores from Wodgina." Geo Surv. W.A. Bull. 48.

Na_2O	—	—	.04
SiO_2	16.19	15.30	12.72
P_2O_5	—		1.08
Ta_2O_5	.67	.40	.47
H_2O+	12.04	8.37	4.16
H_2O-	.88	4.19	3.50
Radium and Helium	present	present	present
	100.05	100.05	99.56
Sp. gr.	4.45	4.13	4.68

Platinum and the Platinoid Metals—The noble metals of the platinum group form two sub-groups, viz.:

(*a*) Platinum, iridium and osmium;
(*b*) Ruthenium, rhodium and palladium.

They are invariably found associated with one another near the outcrops of rocks of a basic or ultrabasic type. In this and in many other respects they differ from all other rare metals, particularly in occurring in nature almost invariably in the metallic state uncombined with non-metallic elements. The exceptions are Sperrylite (platinum arsenide) and Laurite (ruthenium sulphide). All the metals of this group are "noble" metals, *i.e.*, particularly resistant to the action of the air and most common chemical agents. Platinum was first described in 1755, the other metals in the group have been known since early in the 19th century. Lately a claim has been put forward for the recognition of a seventh metal of the group which has been named Canadium. Its existence, however, requires confirmation.

Platinum is by far the most abundant of these metals and is indispensible to many industries and arts. Its demand for jewellery and for acid and fire-resistant chemical ware, and for electrical purposes, is very large, ¾ million pounds' worth being used in the United States alone during 1910.

Iridium is the next most important of these metals, being largely alloyed with platinum to harden and strengthen it.

Osmium, palladium and rhodium are utilised to a small extent. Ruthenium, the least abundant of these metals, has no practical application.

None of these metals has yet been proved to occur in this State, though ultrabasic rocks, the *fons et origo* of such metals, are fairly common and widespread, as, for example, at Kalgoorlie, Northam and Soanesville. A good platinum deposit would be worth infinitely more at the present time than a correspondingly rich gold deposit.

Some years ago two small samples of concentrates were brought to Perth which were said to have been washed out of the bed of one of the tributaries of the Donnelly River. This sand was composed largely of cassiterite and monazite, but in addition carried :—

Sample.	A	B
Platinum, per ton	244.35 ozs.	291.05 ozs.
Osmiridium, per ton	30.20 ozs.	54.90 ozs.
Gold..................	18.47 ozs.	34.65 ozs.

There is some doubt as to the exact origin of these samples, which may possibly have come from N.S.W.

The author has at times looked for platinum in various ores and black sands from localities in which highly basic rocks are known to exist and from other likely localities such as Kalgoorlie, Cossack, Kundip, and Golden Valley Although the method employed (Mingaye's) should serve to detect, on the charges of ores taken, amounts as small as 4 grains to the ton, none of this metal has yet been recognised in any of these ores.

NATIONAL MUSEUM MELBOURNE

PROCEEDINGS

OF THE

NATURAL HISTORY & SCIENCE SOCIETY

OF

WESTERN AUSTRALIA.

SESSION 1911-1912.

July 11th, 1911.

A. Gibb Maitland, Esq., F.G.S., President, in the Chair.

Maurice A. Browne, Esq., B.A., C. J. R. Le Mesurier, Robt. Alexr. Farquharson, Esq., B.A., M.Sc., F.G.S., Miss Edith Nesbit, Miss Nellie Smith, Miss Trevenna, and Miss Edith Richardson were elected members of the Society.

The Anniversary Address on "Relics of the Permo-Carboniferous Ice Age in Western Australia," by the retiring President, Mr. A. Gibb Maitland, was read, *vide* pp. 12 *et seq*.

ANNUAL GENERAL MEETING.

July 27th, 1911.

Frank Tratman, M.D., Vice-President, in the Chair.

Report of the Council for the Session 1911-12.

Your Council has pleasure in submitting the Annual Report and the Financial Statement for the twelve months ending June 30th, 1911.

The present roll of members stands at 62, consisting of 52 ordinary members, 3 junior members, and 7 honorary members, the latter having been increased by the addition of the name of Mr. A. W. Milligan, of Melbourne, a former member of the Council and a gentleman whose work in Australian ornithology is well known.

During the year the Council met 17 times, and there were 12 general meetings, as also 4 demonstrations, while 9 excursions took place to various lcoalities within easy reach of the Metropolis, these including the following places: Cannington, Gosnells, Maddington, West Guildford, Swan View, Boya, Mahogany Creek, and Guppy's Siding.

At the invitation of the Director, a pleasant afternoon was also spent at the Zoological Gardens, South Perth. In these outings the Society was honoured by the presence of Professor David, of the Sydney University; Dr. Danes, of Prague University; Mr. Grant Watson, of the Cambridge University Ethnological Expedition, and other distinguished visitors.

The following papers were read by members at various meetings:- "Pilbarite, a new Mineral from the Pilbara Goldfield," by Mr. E. S. Simpson; "Notes on Radium," by Mr. W. J. Hancock; "Summer Temperatures of the Soil in relation to the Supply of Nitrogen in the Wheat Areas," by Mr. W. C. Grasby; "Bird Day a Plea for the Protection of Birds," by Mr. J. G. Hay, as also by the same gentleman, "Some Geographical Errors and their influence upon Exploration and Settlement" (the latter paper being illustrated by a series of ancient and mediæval maps); and "Nitrogen," by Mr. M. A. Browne. A paper was likewise contributed by Mr. J. H. Maiden, the Government Botanist of New South Wales and Director of the Sydney Botanic Gardens, on "Some West Australian Eucalyptus"; while the Society has also published the second part of a résumé of the Exploration by the German Scientific Expedition of 1905 to South-west Australia, conducted by Drs. Michaelsen and Hartmeyer.

Four useful demonstrations were held during the period under review. The first on "Orchids," by Mr. F. G. Brown; the second on "Insects," by Mr. H. M. Giles; the third on the "Collection, Preservation and Study of Minerals," by Mr. E. S. Simpson; and the last by Dr. Tratman, on "The Classification of Flowering Plants."

In addition to these, exhibits of minerals, plants and various invertebrates, with other scientific objects, have been frequent at the various gatherings, which have been well attended throughout the year.

In compliance with an outside request, Mr. J. G. Hay delivered a lecture at Canning Mills on "The Discovery and Maritime Exploration of Australia," illustrated with maps, and at a later date Miss Eyre gave an address at the same place on "The Adaptation of Flowers to Insects," good audiences resulting on each occasion.

As the outcome also of the reading of Mr. J. G. Hay's paper on "Bird Day," a sub-committee was formed which recommended the establishment of a Gould League of Bird Lovers, which promises to do much for the preservation of our useful feathered friends.

Some changes have taken place during the year among the office-bearers, Mr. A. O. Watkins being elected to the Council in the room of Mr. F. G. Brown, whose resignation was accepted with regret. The retirement of Mr. C. P. Conigrave from holding office as also from the Society as a member was accepted in the month of September last, and Mr. E. S. Simpson for some time kindly consented to act as Honorary Secretary until the eve of his departure on a visit to New South Wales, when Mr. J. G. Hay took up the office at present held.

During the year 1910-11 there were held 17 Council meetings, at which Mr. Hay attended 3 (being appointed latterly Acting Honorary Secretary in the room of Mr. Simpson, on his visiting New South Wales for a holiday); Mr. Watkins, 3 (having accepted a vacant seat caused by the resignation of Mr. F. G. Brown); Mr. Grasby, 5; Mr. Lee, 8; Mr. Cooke, 11; Mr. Maitland, 12; Mr. Simpson, 14; Dr. Tratman, 16; Mr. Giles, 17; and Dr. Thorp, 17.

For a portion of the period the President (Mr. A. Gibb Maitland) was indisposed, and unable to attend the meetings, whilst Messrs. Simpson, Lee and Cooke were granted leave of absence while away from the State.

The financial position of the Society was such as to preclude the possibility of bringing out a fresh number of the *Journal* until lately, when No. 2 of Vol. III was placed in the hands of the printer. This number will be found to contain some valuable and interesting articles in all branches of the Society's work.

The Council has also much pleasure in announcing that since the last Annual Meeting a number of valuable additions has been made to the Library, which now includes a quantity of bound volumes of the "Proceedings of the Royal Society of South Australia," many works on Botany and Zoology, besides paper copies of productions of societies in Australia and elsewhere.

Your Council has further satisfaction in stating that the preparation of a complete index of the volumes already issued by the Society has been undertaken, and it is hoped that the general utility of will be found proportionate to the labour and time bestowed upon its preparation.

In the month of June the Society received a request to vacate the premises occupied gratuitously for some time past in the Agricultural Department, the room being required in consequence of the expansion of the Government professional staff. A short period of respite to look for fresh quarters was granted, and the Minister for Agriculture was duly thanked for his kindness and for the courtesy at all times extended by his staff.

The statement of the Society's income and expenditure during the year ended June 30th, 1910, which will be fully set out in the audited balance sheet attached hereto, may be summarised briefly as follows:—

During the year the total receipts amounted to £61 12s 6d., and the current expenditure reached £29 1s. 2d. The actual excess of receipts over expenditure therefore amounted to £32 11s. 4d., leaving that amount as the balance in favour of the Society.

It may be found necessary in the near future to increase the present low rate of subscription, and members in any case might assist the Council by proposing desirable nominations and so continue the good already happily achieved.

(Signed)

A. GIBB MAITLAND, *President.*

J. G. HAY, *Honorary Secretary.*

STATEMENT OF RECEIPTS AND EXPENDITURE FOR THE YEAR ENDING JUNE 30TH, 1911.

RECEIPTS.

	£	s.	d.	£	s.	d.
To Balance in hand	1	1	0			
,, ,, Bank	1	5	7	2	6	7
,, Subscriptions—						
1909-10, 23 @ 10/6 ..	12	1	6			
1910-11, 52 @ 10/6 ..	27	6	0			
2 @ 5/-		10	0			
1 (part), 2/6		2	6			
1911-12, 4 @ 10/6 ..	2	2	0			
				42	2	0
,, Government Grant				12	0	0
,, Sale of *Journals*, etc.				5	3	11
				£61	12	6

EXPENDITURE.

	£	s.	d.	£	s.	d.
By Library	1	1	0			
,, Furniture	1	12	0			
,, Printing and Stationery	16	9	0			
,, Petty Cash, Postages, etc.	8	15	8			
,, Caretaker	1	3	6			
				29	1	2
,, Balance at Bank	34	18	4			
Less outstanding cheque	2	7	0			
				32	11	4
				£61	12	6

Perth, July 10th, 1911.

(Signed) GEORGE PICK, F.C.P.A ,
Accountant.

A. GIBB MAITLAND,
President.

C. G. THORP,
Hon. Treasurer.

August 8th, 1911.

E. S. Simpson, Esq., B.E., F.C.S., President, in the Chair.

The List of Donations to the Library was read.

The following specimens were exhibited :—The "Wild Violet," falsely sometimes called a Lobelia (*Imidium floribundum*), from Coolgardie ; and a species of Casuarina from between Claremont and the Coast, by Frank Tratman, M.D.

Two meteorites (Siderites), from Premier Downs, on Nullabor Plains, and Mount Dowling, at the northern end of the Yilgarn Goldfield, by E. S. Simpson, Esq., B.E., F.C.S.

September 12th, 1911.

E. S. Simpson, Esq., B.E., F.C.S., President, in the Chair.

Mrs. E. S. Simpson and Mr. A. J. Robertson, B.E., B.Sc., were elected members of the Society.

The List of Donations to the Library was read.

The following communication was read :—

1. The Federal Capital Site. By J. G. Hay.

The following specimens and photographs were exhibited :—

Photographs illustrating the neighbourhood of Boya, by J. G. Hay.

Gold crystals from the lid of a crucible, by A. O. Watkins.

Plants collected at the excursion to the Lime-kilns beyond Subiaco, viz., *Caledonia latifolia, Logania longifolia, Scaevola nitida,* and *Clematis aristata,* by Frank Tratman, M.D.

October 10th, 1911.

E. S. Simpson, Esq., B.E., F.C.S., President, in the Chair.

Mr. J. J. East, Miss Lockley and Mrs. E. B. Sharman were elected members of the Society.

The List of Donations to the Library was read.

The following communication was read :—

1. A Description of Some Artificial and Reconstructed Gems. By J. H. Boas, Esq.

November 4th, 1911.

E. S. Simpson, Esq., B.E., F.C.S., President, in the Chair.

The List of Donations to the Library was read.

The following communication was read :—

1. Unusual Types of Petrifaction from Dandarragan. By E. S. Simpson, Esq.

December 12th, 1911.

E. S. Simpson, Esq., B.E., F.C.S., President, in the Chair.

The List of Donations to the Library was read.

The following communication was read :—

1. The Causes of the Fertility of the Western Australian Semi-Arid Wheat Lands. By G. A. Pfister.

January 9th, 1912.

E. S. Simpson, Esq., B.E., F.C.S., President, in the Chair.

Mr. F. Aldrich was elected a member of the Society.

The List of Donations to the Library was read.

The following communication was read :—

1. A Triumph of Mendelism in Wheat Breeding; Professor Biffin's work at Cambridge University. By W. Catton Grasby, F.L.S.

The following specimens were exhibited :—

Botanical specimens from the Yallingup and Margaret River Districts, by Frank Tratman, M.B., B.S.

Water-colour paintings of plants, by A. J. Hall, Esq.

Radio-active Mineral—Thorogummite from Wodgina, by E. S. Simpson, Esq., B.E., F.C.S.

February 13th, 1911.

E. S. Simpson, Esq., B.E., F.C.S., President, in the Chair.

The List of Donations to the Library was read.

A discussion on the Divining Rod, in which several members participated, took place.

March 12th, 1912.

E. S. Simpson, Esq , B.E., F.C.S., President, in the Chair

The List of Donations to the Library was read.

The following paper was read :—

1. The Protozoic Rocks of the North of Western Australia. By Ludwig Glauert, Esq., F.G.S.

The following specimen and map were exhibited :

Beaufortia squarrosa, by Frank Tratman, M.B.

Geological map, by L. Glauert, Esq., in illustration of his paper;

April 16th, 1912.

E. S. Simpson, Esq., B.E., F.C.S., President, in the Chair.

Mr. E. H. Hardy was elected a member of the Society.

The List of Donations to the Library was read.

The following paper was read :—

1. An Investigation into the Structure and Functions of the Skin of the Potato Tuber. By Dr. Stoward.

May 21st, 1912.

E. S. Simpson, Esq., B.E., F.C.S., President, in the Chair.

Harcourt Harper, Esq., H. R. H. Hillman, Esq., S. B. Murton, Esq., and Mrs. Shelton were elected members of the Society, and Miss Kathleen Shelton a junior member.

The List of Donations to the Library was read.

June 11th, 1912.

E. S. Simpson, Esq., B.E., F.C.S., President, in the Chair.

Wilfred B. Alexander, Esq., B.A., and Mr. G. L. Sutton were elected members of the Society.

The List of Donations to the Library was read.

The Anniversary Address on The Rare Metals and Their Distribution in Western Australia, by the retiring President, Mr. E. S. Simpson, was read, *vide* pp. 83.

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NATIONAL MUSEUM MELBOURNE

THE

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AND

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The Author of each Article is alone responsible for the facts and opinions recorded.

VOLUME THE FIFTH.

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Natural History and Science Society
OF
Western Australia.

LIST OF THE OFFICERS AND COUNCIL,
1912-13.

Elected July 16th, 1912.

Patron:

HIS EXCELLENCY THE GOVERNOR,
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C. G. THORP, M.B., C.M.

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General Meetings of the Society are held on the second Tuesday in each month, except January and February.

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THE JOURNAL
OF THE
NATURAL HISTORY AND SCIENCE SOCIETY
OF
WESTERN AUSTRALIA.

VOL. V.

TWO NEW METHODS OF WEIGHING THE CORNETS IN THE ASSAY OF GOLD BULLION. By A. OCTAVIUS WATKINS,* A.R.S.M., F.G.S. (Read October 8th, 1912.) Printed in full in the *Chemical News*, November 12th, 1912.

COLOUR PHOTOGRAPHY. By C. G. THORP, M.B., C.M. (Read November 11th, 1912.)

AN OUTLINE OF THE WORK OF THE NEWLY-FORMED ASTRONOMICAL SOCIETY OF WESTERN AUSTRALIA. By H. B. CURLEWIS,† B.A., F.R.A.S. (Read December 10th, 1912.)

MODERN INVESTIGATIONS OF PROBLEMS CONNECTED WITH SEA FISHERIES. By W. B. ALEXANDER, B.A. (Read February 11th, 1913.)

DESCRIPTION OF A ROCK SHELTER WITH ABORIGINAL MARKINGS, AND AN INDURATED CAST OF A FOOTPRINT AT THE GREENOUGH RIVER, AND A CAVE DWELLING AT NARANDAGY SPRING, LOCKIER RIVER. By W. D. CAMPBELL, A.K.C., F.G.S., A.M.I.C.E., L.S. (Read March 11th, 1913.)

This rock shelter is situated about 23 miles east of Geraldton and is in the Greenough River district. It is two chains within the north boundary of Loc. 2,989, and 15 chains east of the south-west corner of Loc. 2,160, and is one mile south of the permanent spring of water now known as "Sandspring," where the homestead of that name is situated.

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* Assayer to the Perth Mint.
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This rock shelter is formed in a remnant of the escarpment of a low hill composed of ferruginous sandstone, horizontally bedded, and some stray blocks of the same material there present hard and indurated surfaces, that have been availed of by the aborigines for making stencilled paintings of hands and weapons, etc. The floor and approaches are composed of ashes and fragments of charcoal accumulated among and over detached fragments of rock, and form a very typical "kitchen-midden" of a cave dwelling.

There are other shelters along the escarpments of the flat-topped hills in the neighbourhood, caused by the weathering away of the more friable sandstone below the ferruginous beds or laterite covering forming the tops of the hills, but though some of these show signs, by their middens, of having been inhabited to a lesser extent, the soft sandstone forming the walls has been disintegrated by the action of the weather, and has not presented a suitable surface for paintings, and the shelters are not so conveniently situated as this one, which is only 15 or 20 feet above the valley which it overlooks, where corroborees may have been held.

The shelter faces almost due east and is 27 feet long, 12 feet deep, and 8 feet high at the outer face. Fig. No. 2, Plate II, shows the general aspect of the shelter, viewed from the south side. Fig. No. 3, Plate II, is a nearer view, showing some of the paintings, a hand and two oval figures about the size of large duck eggs. Fig. No. 4, Plate III, shows the sloping roof and back of the cave viewed from the front.

The principal paintings are seen at mid-height on the right-hand side extending diagonally upwards to the left-hand upper corner of the photograph. These in rotation are as follows: - A pair of female hands, a man's right hand, a man's left hand, a pair of men's hands with the thumbs touching, and the imperfect paintings of hands below these. About a foot above this line there is a very fresh outline of a tobacco pipe and a womera for throwing spears, while above and between these again are two hands. Near the bottom of the cave are seen the two egg-like figures already alluded to ; also the circular-shaped marks beyond.

These paintings are evidently of various ages, but are all made in the same way and are similar to those of the aboriginals of the Eastern States. They have been made by placing the hand or article against the rock and dabbing the surrounding surface of the rock with a pigment made of a mixture of white ashes and fat, by means of a green stick the end of which has been bruised into a brush-like tip. This mixture forms a hard cement. The durability of these paintings is increased by the oily nature of the pigment soaking into the sandstone. In modern times this pigment is commonly called "settlers' cement," it being used for repairing leaks in water-troughs and barrels.

I made a trench across the floor from the back of the shelter, below the pair of woman's hands, to the front, about 7′ 6″ long, and found an average depth of nearly 1′ 9″ of ashes, among the lower half of which I found a few fragments of small bones, probably those of a kangaroo, and a small rib, possibly of a bird, and a few quartz chips, which may or may not have been artificially made. They are, however, not common in this neighbourhood. Fig. No. 1, Plate I, shows a section along this trench.

The most recent ashes were in front of the large rock lying across the floor at the south end, and I sunk a hole at this spot and at two or three inches depth came upon rusty portions of an old pair of shears, below which were grey ashes; at twelve inches depth were some quartz chips, and below this again a few fragments of bones. Rock was met with at eighteen inches depth. None of the paintings had been interfered with or injured when the above examination was made, nor had the floor been disturbed.

At "Minnenooka" homestead, about five miles west of this cave, I was shown a remarkable natural cast of an aboriginal's footprint, formed of ferruginous sandstone, evidently of very considerable age, which had been found over thirty years ago in the Greenough River valley by the late Mr. R. E. Readhead, the owner of "Minnenooka." Unfortunately, no details of the locality are available. The total length is 11 inches, breadth 4 inches, and thickness 3¼ inches. Figs. No. 5, Plate III, to 7, Plate IV, show this cast viewed from different directions.

The cast shows that successive layers of mud have built it up; but it is quite homogenous and presents a smooth surface and even portrays the foldings of the skin and the muscles. The latter show great development, and its general character and breadth unmistakably indicate that the footprint has been made by a well-developed male aboriginal of the same type as still survives, though the cast is practically a fossilised cast. The photographs are registered in the Geological Survey office, Nos. 262 to 267.

The cave shown in Fig. 8, Plate VI, (Geological Survey negative No. 347) is situated near the top of a small isolated hill, about twelve miles north-easterly from Mingenew, and three miles south-easterly from Mt. Melara, and one mile south of the Narandagy Spring, Lockier Valley (see map) Plate I. It has not any aboriginal drawings, but the floor and slope in front of the cave show that it was used for a long time as a dwelling place by aboriginals. The cave faces the north-east, and it has a very picturesque and extensive outlook.

Description of a Cave with Aboriginal Markings at Appertarra, and of a Cave and Rock Shelters at Willow Gully, Nonga and Norman Well, Northampton. By W. D. Campbell, A.K.C., F.G.S., A.M.I.C.E., L.S. (Read March 11th, 1913.)

This cave is within the road area, which skirts the east side of Lot 11, Appertarra, about six miles north-east of Northampton, and about ten chains south of the north-eastern corner of this lot. It is three-quarters of a chain from the fenced side of the lot, and faces north-east. To the north of this point there is the head of a small valley trending north-easterly, and it is bounded here by an escarpment about nine feet high, forming the edge of the tableland. The cave is in this escarpment, and it has evidently been formed by the soakage of water down a small fissure, which is perpendicularly above the back portion of the cave. The kaolinised surface of the granite has here become silicified, rendering it hard and able to form the roof of the cave. The cave is fifteen feet wide and fifteen feet deep, and it is four feet high at the entrance.

At the back of the cave there are stencilled paintings of twelve left hands, three womeras, and two sticks, all in white relief, as can be seen in Fig. 2, Plate VII.

Fig. 1, Plate VII, shows a section of the cave. The floor is sandy, with a considerable admixture of wood ashes and charcoal, and the usual kitchen midden slope has been formed outside the entrance of the cave.

In order to make this road passable for traffic it will, unfortunately, be necessary to make a cutting through this escarpment, which will endanger the existence of the cave, unless the cutting is made close to the west side of the road area. It is to be hoped that when the work is undertaken this precaution will be adopted.

Description of a Rock Shelter and Cave at Willow Gully, near Northampton.

These are situated about $1\frac{1}{2}$ miles from the entrance to the Bowes River, just within the north boundary of Loc. 116, where the valley is contracted by the hills to a width of about a quarter of a mile. They are about three-quarters of a mile from Mr. M. Williams' "Willow Gully" homestead, to which place there is a good road from Northampton, distant between 11 and 12 miles. The position is shown in the enlargement of the plan, Plate VIII.

On the north side of the river at this place there is a sandstone cliff about 25 feet high, of Jurassic age, and there is a gentle slope from its base to the river. The rock shelter is at the east end of the cliff ; it faces the east, and is about 30 feet long and

8 feet wide. The back of the shelter presents a conveniently upright and smooth surface for drawing upon, and there are various drawings and markings, some of which are super imposed upon others of older date that had become faded or decayed away. The drawings comprise the usual aboriginal white-daub stencillings of hands and weapons (see Fig. 3, Plate IX). There are eleven right hands, at least three of which are evidently female hands, and twelve left hands, also three pairs of hands; total, twenty-nine hands and one right foot. The weapons represented are seven boomerangs, horizontally placed with the curvature of the ends downwards. The paint material is either white clay or white ashes mixed with fat, which I understand is called by the aboriginals "woolga." Over these paintings are drawn some line drawings in charcoal and red and yellowish ochre; of these, the most distinct figures are those represented in the third line of Fig. 1, Plate VII. There are also represented twelve full-size emu footprints. The floor of the shelter is sandy, but the character of the substratum was not investigated.

The cave which has been mentioned is about 2¾ chains westerly along the cliff from the rock shelter just described. It is about 20 feet wide and 20 ft. deep. The height at the entrance is 5 feet 4 inches, which increases somewhat inside (see Figs. 4 and 5, Plate X).

At the back of the cave there are stencilled paintings of three male left hands and a bifurcated figure, which is probably a phallic symbol, and a branching figure. The two latter are painted, not stencilled. On the roof there are two male left hands and one right and one left female hands, and on the west side there is one male hand. The most remarkable and largest figure in the cave is on the east side, where a large snake has been drawn, not stencilled. It covers about seven feet length of rock face. A hole or circular shaped object is drawn near the head of the snake (see Fig. 1, Plate VII).

A rock shelter occurs at a small isolated table-top hill at the head of a valley that extends south-easterly into the sand plain tableland 2¼ miles south of Norman Well, and about 6 miles from Northampton. It is in sandstone and has been weathered out of the unaltered rock under a quartzite capping about 2 feet thick. It is 8 feet deep, 3 feet 6 inches high, and 6 feet across. The magnetic bearing of Brown Hill is 333° from here, and the distance 2 miles 70 chains. There are no aboriginal markings, but there is an extensive kitchen midden on the south side of the hill and near the shelter. There are probably rock holes in the granite forming the bed of the watercourse, in which the aboriginals could obtain water. The easiest way of reaching this place would be by the road from Isseka Siding to Location 2,672.

About 6½ miles north-easterly from Willow Gully, and half-a-mile north of Granite Hill, Nonga Agricultural Area (see Fig. 6, Plate XI and map, Plate VIII) there is a small escarpment of sandstone which caps the granite here, and there are several small rock shelters at its base, but there are no drawings or markings; possibly they may have been there but have disappeared through the friability of the rock. The kitchen-midden slopes in front of the escarpment show that the place was used as a dwelling by the aboriginals. The smooth grassy appearance of these midden slopes can be seen in the plate No. XI.

THE POTATO MOTH: AN EXPERIMENTAL INVESTIGATION INTO THE METHODS OF CONTROLLING ITS RAVAGES IN STORED TUBERS.

By F. STOWARD, D.Sc. (Birm.).*

ABSTRACT.

(Read May 13th, 1913.)

One of the most troublesome insect pests apparently present wherever potato culture forms a branch of agricultural industry in regions where the prevailing conditions of climate are warm and dry during the period of crop growth is the potato moth (*Phthorimea operculella Zell*). This is notably the case in California, South Africa, India, and the different States of the Australian Commonwealth. The exceedingly mild and equable conditions which normally mark the late spring and summer of Western Australia are distinctly favorable to the prevalence and activities of the pest.

The active agent of infestation is the larva of the moth, which is not only capable of ravaging and causing the almost complete destruction of the growing plant, but also of the stored tuber. Great difficulty is therefore experienced during seasons when the pest is present in large numbers and the season is a dry one in preserving against its ravages stored tubers destined to be used as "seed." Infestation of the crop tuber may occur under certain conditions *in situ* even prior to the lifting of the crop, not as has sometimes been stated by the larva penetrating the stem of the ravaged plant and thus entering the tuber, but through actual exposure of the tuber to infestation as a result of insufficient or untimely earthing up, or the occurrence of cracks in rapidly drying, stiff soils through lack of adequate cultivation. Another common method by which infestation of tubers takes place and usually immediately after the lifting of the crop is either from exposure in the field or from the practice of covering these with haulms on which the moth is present as a means of protecting the tubers from the sun's heat. Under whichever of these circumstances infestation occurs, and whether it commences in the tuber attached to the growing plant, immediately after the digging of the crop, or in the storehouse, the chain of events is practically the same: the eggs of the moth are deposited, chiefly in the "eyes" of the tuber, these eggs hatch in from four to six days, according to conditions, and the young larvae, which at this stage are minute objects, make their appearance. These at once attack and destroy the tender buds which collectively constitute the "eye" of the tuber. (Fig. 1.) The infested tuber is thus at an early stage rendered useless for seeding purposes. The later stages of the attack not unfrequently proceed with considerable rapidity, and are marked by the gradual tunnelling into and consumption of the starchy tissue of the tuber by the larva ; the more advanced stages of larval infestation lead to the almost complete destruction of the tuber, which finally rots as a result either of fungal or bacterial invasion, or dessicates and mummifies (Fig. 2). The net result of larval attack and the activities of commonly associated fungi and bacteria which are pathogenic to the potato tuber is, on the one hand, to render it valueless as a commercial product, on the other to furnish a medium for the propagation of the pest. The larva thrives at the expense of the tuber, increases markedly in body dimensions, and then pupates. The pupa remains for some time in a dormant condition, the life cycle being completed by its metamorphosis into the moth. Incidentally it may be stated that in the case of plant invasion the eggs are chiefly deposited on the leaflets, through the epidermis of which the young larva penetrates and thence into the mesophyll, which is gradually consumed, the infested leaf as a result of the dessication of the remaining epidermal layers presenting the characteristic parchment-like appearance which is diagnostic of larval invasion of the vegetative portion of the plant.

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Various methods have been advocated from time to time to control the pest in stored tubers. These methods may be conveniently set out as under :—

(1) The dipping of tubers in toxic solutions, as a means either of destroying the infesting agents in tubers already attacked, or of preventing infestation ;

(2) The dressing of tubers with solid chemical substances as a means of preventing infestation ;

(3) The spraying of tubers with various antiseptic or odoriferous mixtures either in solution or suspension as a means of protecting tubers against infestation ;

(4) The fumigation of tubers as a means of destroying the infesting agents.

The potato moth normally goes through a certain life cycle, which embraces the following phases or life forms: the egg, larva and pupa. At the outset it was recognised that, excluding the moth itself, these different life forms are very diversely insensitive to the action of toxic chemical compounds. Thus, in the course of this experimental enquiry it has been shown that of these different units when exposed, in separate series of experiments, either to the influence of formalin in solution or to the poisonous fumigant carbon bisulphide, the egg is the most and the moth the least insensitive, the degree of insensitivity of these diverse life-forms of the insect towards these reagents being in the order the egg, pupa, larva, moth. In addition, destruction of the larva, particularly by the former means, is further complicated according as it is in the substance or on the surface of the tuber.

Experiments, in which larva-infested tubers were dipped in solutions of formalin of varying strengths (½-1 pt. to 15 gals. water) resulted in showing that a steeping of at least 48 hours' duration is necessary to ensure complete annihilation of the adult larvae when in the tuber. Similarly established control experiments in which water served as the steeping medium demonstrated the fact that it is as effective as steeping in any of the abovementioned formalin solutions. The comparatively slow rate of diffusion of formalin solution into the starchy tissue of the steeped tuber, the power of relatively rapid movement possessed by the larva, and its possible power of adaptation to an increased tension of CO_2, lead to the conclusion that in these experiments extinction of its vitality is due to asphyxiation rather than to direct formalin poisoning. The point is of economic importance since destruction of the larva may, in these particular circumstances, be as effectively accomplished by steeping infested tubers in water alone as in a solution of formalin. The chief function of formalin is to suppress bacterial development, which invariably occurs after prolonged steeping of infested tubers in water, the substances which pass by diffusion from the tuber into the water rendering it a comparatively rich nutritive medium for certain bacterial types.

Even when isolated adult larvae are placed in formalin solutions (½-1 pt. to 15 gals. water), or in a solution of mercuric chloride of the strength mentioned below, thus eliminating the complicating factor of diffusion and ensuring complete contact of the larvae and solution, an immersion of 6 hours in the former and of 2 hours in the latter fails to ensure their destruction. An immersion of 6 hours' duration in a solution of 1½ per cent. of copper sulphate, of 2½ per cent. sodium carbonate, or a mixture of equal volumes of these two solutions does not lead to annihilation of the larvae.

The egg of the moth is particularly resistant to the action of such poisons as formalin or mercuric chloride, or sulphuric acid of either 5 or 10 per cent. strengths. Thus with egg infested tubers steeped either in formalin solution (2 pts. to 15 gals. water) for 48 hours, or mercuric chloride solution (1 oz. to 8 gals. water) for 12 hours, or in a 10 per cent. solution of sulphuric acid for 2 hours, the eggs were not destroyed by any of these treatments, the experimental tubers in each instance becoming as badly infested as the corresponding controls of egg-infested tubers which had not been subjected to treatment.

The pupa is equally difficult to annihilate by these means. Steeping experiments in which these objects, divested of their cocoons, were used resulted in showing that they survive after immersion in a solution of formalin (1 pt. to 15 gals. water) for 48 hours, or of mercuric chloride (1 oz. to 8 gals. water) for 30 hours.

The use of mercuric chloride or of lead arsenate as a preventive against infestation is unsatisfactory. Uninfested tubers after a steep of half an hour's duration in mercuric chloride solution (1 oz. to 8 gals. water) or in a suspension of lead arsenate for five minutes, subsequent drying and exposure to infestation were as readily and extensively attacked as tubers which had not been subjected to treatment. Thus in these experiments separate lots of uninfested treated tubers, placed in properly closed sterilised receptacles, were exposed to infestation from (*a*) adult larvae, (*b*) juvenile larvae, the latter derived from eggs deposited by moths introduced at the time of the initial establishment of the experiments. In either case the tubers were infested, the larger proportion of the eyes destroyed, and the infesting objects completed their life cycle as rapidly as in the case of similarly established experiments in which the tubers were not subjected to immersion in either of these preparations.

Spraying of uninfested tubers for the retardation of infestation has not furnished satisfactory results. Several lots of uninfested tubers thoroughly sprayed with one or two per cent. phenyle, a substance possessing a repellant odour, or with freshly prepared copper sulphate-soda mixture of the strengths above mentioned, then dried and exposed to moth infestation, as readily succumbed to it as did similar but unsprayed material. Under the selected conditions employed in this experimental enquiry steeping or spraying methods of treatment as an effective means of ensuring the destruction of the infesting agent or of preventing infestation of tubers have proved to be quite ineffective.

The employment of finely powdered air slaked lime or mixtures of lime and sulphur, or lime and Paris green, in varying proportions, applied as a dressing to uninfested tubers, while affording a small measure of protection against the pest under certain circumstances, have not furnished a reliable means of preventing infestation. Their principal drawback is that on sprouting protrusion of the sprouts through the thin layer of powdered substance takes place and renders the tuber readily open to infestation.

Extensive series of experiments on the use of carbon bisulphide as a fumigant used solely for the annihilation of the pest have shown that (*a*) the destruction of the larvae either in the substance of the tuber or external to it is accomplished by fumigating larva infested tubers with this compound at the rate of 1 or 2 lbs. per 1,000 cubic feet of space for a period of 16 hours. In the annihilation of the egg and pupa, however, using either of these amounts of carbon bisulphide per unit of space, the fumigation period must not be less than 48 hours, and to ensure complete destruction of these life-forms the application of a second fumigation four to six days after the first is necessary. The selection of the interval between the application of the first and second fumigation depends on the fact that any eggs or pupae which may have survived the initial fumigation are either approaching the larval or moth stage respectviely and are thus readily destroyed.

In an experimental study of the influence of carbon bisulphide fumigation on the vitality of the tuber buds, the culinary and storage qualities of the tuber and the results of planting fumigated "seed" tubers, the author reports that sound, infested, and uninfested tubers may be intermittently fumigated with 1-2 lbs. of carbon bisulphide per 1,000 cubic feet of space for a period of 48 hours two, three or four times without causing injury to the tuber buds or impairing the storage and edible qualities of the tuber.

THE CRETACEOUS FOSSILS OF THE GIN-GIN CHALK AND THEIR GEOLOGICAL RELATIONSHIPS. By A. GIBB MAITLAND, F.G.S. (Read June 10th, 1913.) Printed as Geological Survey Bulletin No. 55.

A CONTRIBUTION TO THE STUDY OF AUSTRALITES. By C. G. THORP, M.B., C.M., BEING THE ANNIVERSARY ADDRESS OF THE PRESIDENT, SESSION 1912-1913. (Delivered July 11th, 1913.)

As your retiring president, I must express my regret that I have been unable more efficiently to discharge my duties to the Society during my year of office, and that I was compelled by considerations of health to leave Perth during this, to me, most important period. Will you allow me to take this opportunity to tender to you my most sincere thanks for the great honour that I feel that you have done me in electing me to the high office of president for the year which is distinguished above all other years, for Western Australia, by the foundation of our University, and which should mark the commencement of a flourishing and useful period for our Society we hope, the commencement of a new era.

For some years past I have interested myself in, and given much thought to, the problem of the origin of Obsidianites, or, as they are more scientifically and better termed, Australites, Billitonites, or otherwise, according to the locality in which they are found.

Australites, of which we know most, as they occur here, are small masses of a dark glass, found almost throughout Australia, south of the Tropic of Capricorn, and in Tasmania. A few have been found north of the Tropic of Capricorn, but very few.

The map (Plate XVII) shows the localities where Australites have been found, and is as up-to-date as has been found possible. It also shows the distribution of Billitonites, as far as recorded; as in my opinion the two are identical and should be considered only together and as one whole. Without doubt, many localities of finds have not been recorded on account of the finder knowing neither what they are, nor the interest attached to them.

The glass of which Australites, and apparently Billitonites, are composed is a singularly pure one, containing practically no small crystals, nor other inclusions, except bubbles., thus showing that it has been very quickly chilled from a perfectly fluid condition; its brittleness, moreover, would support this.

There have been several analyses of Australites made, some of which will be found in the table at the end of this paper, together with analyses of Billitonites and Moldavites, for purposes of comparison. It will be noticed that the composition of Australites and Billitonites are identical, while that of Moldavites differs materially from them.

Australites, Billitonites and Moldavites are three somewhat similar bodies, found respectively in Australia, in the East Indian Islands, and Malay Peninsula, and named after Billiton, an island to the south-east of Singapore, where there are tin mines, and in Bohemia and Moravia, being named after the river Moldau, in Bohemia, where they were first found. It is my intention to discuss in this address their similarities, their differences, and the problem of the formation of the two former. Similar bodies have been recovered from Columbia and Arizona, in America, and in the localities mentioned by Dr. Munn in his paper, published by the Geological Survey of Victoria, but few particulars are available here.

The composition of Australites and Billitonites is peculiar, in that it differs from that of most known Obsidians, I understand, by combining with a high lime content always more, and sometimes considerably more, potash than soda. As Moldavites with a smaller proportion of lime, contains a still greater proportion of potash to soda, this would probably show that Obsidians of this character are more viscid when fused, or otherwise better adapted to form these objects. This may perhaps be the reason why they are not more universally produced, and may also lead to the discovery of the volcanoe, or volcanoes, whence they are derived. The high lime content is apparently the most important factor, as may be judged by the much more perfect shapes constantly presented by Australites when compared with Moldavites.

If a glassy lava of this composition were erupted in a large flow it would probably maintain its heat sufficiently long to permit some crystals to separate out, and in time, as has been observed elsewhere in other Obsidians, the molecular structure might so alter that the entire mass would become crystalline. From this I infer that Australites and Billitonites have been suddenly chilled from a fluid state, even though the volcano that produced them might not discharge apparently a perfectly glassy lava.

Two theories have been propounded to account for the formation of these glass bombs and their deposition in the places where we find them, viz.: the Meteoric and the Bubble theories. both hypotheses being supported by well-known sound scientific men; and while I hold most strongly to the latter, and must confess my total inability to appreciate the validity of the arguments in favour of the former, and against the latter, it is impossible not to acknowledge that there are difficulties, very hard to explain, and that there has been no actual proof. Thus it can only be regarded as the best working hypothesis at the present moment, and liable to be displaced if at any time a better explanation were forthcoming, or more convincing proof, of their meteoric origin were found.*

Their formation has, in my opinion, been spread over a considerable geological epoch, as they occur in Victoria and Tasmania, in what are believed to be late Tertiary or early Quaternary deep leads, while in Western Australia they are found upon the surface of the sand plains, or the mud of lakes, often with a perfectly clean glazed surface showing no sign of wearing by blown sand, as so many others do, and difficult to believe not to be of very recent origin. In fact, no valid reason can be adduced against the supposition that in all probability they are falling to-day as they have fallen from time to time through all these many years. By this I do not wish it to be understood that in the Eastern States Australites are found only in the deep leads, and in Western Australia only on the surface. In all the Eastern States, where they are found at all, they occur also on the surface, sometimes on the tops of hills; while in Western Australia they may be met with below the surface. One would think that those found on the tops of hills must be recent, or comparatively so, at any rate, much more recent than those in the deep leads, as the hills themselves must have altered since the time of the deposit of those in the old river beds. This is proved by the denudation of the hills necessary to fill up the latter. Such ancient valleys perhaps now constituting hills in the altered configuration of the surface.

Is it conceivably possible, even if we eliminate the effect of erosion, that an Australite could lie on the surface, on the top of a hill or eleswhere, since Tertiary times without being destroyed by moving stones, hot and cold weather, wind, bush fires, kicks of animals, or other accidents, even if it escaped being picked up by an emu for its crop, or by an aboriginal medicine man as a charm? Please remember this when I describe to you the beautiful hollow Australites that are now in the Melbourne Museum (Plate XVIII, Figs. 1 and 2), and I will ask you whether they could have remained unbroken on the surface since Tertiary times or indeed for very many years. This is making no allowance for the effect of weathering on the Australite itself, which in a few years may amount to little, but as it is scarcely necessary for me to remind you, we are not speaking of a few years, but possibly half a million—a period we can scarcely imagine.

It does not matter from what point of view we regard it, an Australite on the surface cannot have been deposited at the same time as those found in the old river beds of the deep leads. They cannot thus be all contemporaneous, and if not contemporaneous it is exceedingly difficult to understand why, if they are meteorites, one and the same small portion of the surface of the globe should be picked out each time for them to fall there only.

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* I have not mentioned what are called Fulgurites, which are believed to be due to the fusion of sand by the heat generated by lightning discharging at that spot, as they consist apparently of a rough tube and do not resemble in any way the beautiful regular Australites or even Moldavites.

The Bubble theory, as propounded by Mr. Dunn, in his own words is as follows :—

> "These bodies represent the 'blebs" of obsidian bubbles. From the Eocene period to recent times volcanoes were in active operation in Australia. In Victoria there was remarkable activity. During the outburst bubbles of glass of varying size were formed in the vents, and were carried up in the ascending gases to great heights. The bubbles were dispersed according to the direction of the wind, and in a few hours may have been carried for hundreds of miles. As they cooled, they would fall towards the earth and either the act of coming in contact with the rocks, or the differences in temperature, would shatter the frail glass bubble, but the bleb which had formed at the bottom would remain. Chips would fly off on changes of temperature, just as they do from slag or unannealed glass, and this has taken place. The buttons are the blebs of single bubbles, hence their symmetry. Around the edges of these the rim when the glass bubbles break away, is often plainly visible. The examples contracted in the middle are the blebs of double bubbles, hence their peculiar form, and round the edge of these the rim where the bubble was firmly joined to them is apparent in some cases. The stopper like bodies are blebs of a heavier glass and around their edges the line where the bubbles joined them appears to have chipped off. In the case of the remarkable hollow sphere, previously referred to, it is the bleb of a large glass bubble, and the step around the periphery marks the line where the bubble joined this hollow bleb. The dispersal in greater abundance over some tracts would indicate the prevalent direction of the wind, as well as the direction from which they were derived. These bubbles were undoubtedly blown in volcanoes. Whether these volcanoes are the points of eruption so common in the southern portion of Victoria or not has yet to be determined."

I find that most persons believe, as I believed myself before trying it, that the bleb on a bubble is formed at its lowest point, and is in fact the scar that closes the site of its last attachment to its source. This is an entire mistake. Let anyone blow a soap bubble with a bleb on it, and he will see the bleb is on the very top. It is really the point first forming, while as the bubble floats off when complete the scar of its formation closes over, so as to be indistinguishable, and immediately the bleb, by its own weight, either turns the bubble over or slides down its side, so that it becomes the most dependent part. (Plate XIX, Fig. 2.)

I find on again trying to blow a bubble with a bleb on it so that I can photograph it for this paper that it is by no means so easy as I thought, or as the late Mr. J. B. Allen appeared to find it.

Possibly, as Mr. Dunn suggests, the outer loosely attached ring of the button form of Australite is formed of the superfluous glass running down from the bubble and consolidating round the bleb, but the bleb itself would be formed, as in a soap bubble, at the top, becoming dependent later. This explains why

Australites show so little flow structure in their central mass, or at most just a smooth circular flow, but as in the button form demonstrated by Mr. Dunn in his last paper on the subject any violent whirls are confined almost entirely to that easily detachable outer ring, which is not represented in our conical form.

This hypothesis can only be absolutely proved by seeing the process actually at work, and finding on the spot bubbles, or at least broken bubbles with blebs that have for some reason failed to be caught by the air current that would carry them away.

It will, in my opinion, be found that Billitonites are, some of them, these failures, as they may be called ; some, as I say, from missing the sufficient upward blast and some from the clumsiness of deformity, while others are really Australites which have chanced to go north instead of coming south (Plate XXI, Figs. 1 to 4). It may, I think, be said that the bubble portion of the problem is more than half answered by the existence of the hollow specimens to which reference will be made later (Plate XVIII, Figs. 1 and 2).

The problems at present requiring special research, apart from the exploration for the actual volcano, are physical and mathematical. Physical, to work out the properties of the glass of which these bodies are formed, and to learn by actual experiment the possibility or impossibility of forming bubbles of this material sufficiently thin, yet rigid enough when filled with a light gas, to float in rarified air, or rather to sink slowly in this medium. To learn the mode of formation of the dumb-bell, long narrow and other aderrant forms, whether they are caused by the junction of two bubbles which afterwards unite entirely without a septum or from two or more blebs on one bubble which have run together and united. Many of the irregular forms are, without any doubt, caused by the breaking, chipping and sand wearing of the regular normal shapes. Mathematical, to determine whether, in the event of bubbles being formed by natural means and thrown with sufficient force into the air to reach the distributing wind, they could remain suspended long enough to allow them to be carried to the localities where they are now found. Much accurate data, also requiring research, would be necessary to get reliable results.

At the very commencement of my first introduction to these most interesting bodies I was so fortunate as to be able to examine a very large collection of them. The peculiarity noticed at once, and that struck me most particularly, was the curiously few patterns produced and the almost mathematical exactness exhibited in their production. This latter is one of the most remarkable things of which I know. These few definite patterns are quite as accurately matched one to another as living animals. They may and do differ in size, but they might almost, as far as their shapes are concerned, have been turned out from an engineer's workshop by a lathe, or at least as fine castings before turning.

Mr. Dunn's paper explaining his bubble hypothesis immediately appealed to me as affording a clear reason for a peculiarity in each and every one of the different patterns, viz.: a very well marked ridge, sometimes almost sharp, running in a definite line round each.

An Australite, of whatever pattern it may be, is always larger on one side of this circumferential ridge than the other, as it naturally would be in the bleb of a bubble. Again, in the most common form, at any rate in Western Australia, there appears to be a broad ring of facets quite distinctly marked and separated from each other by intervening raised lines forming a somewhat conical body bounded above and below by convex discs and looking unquestionably as if something had been chipped off all round between these discs, whilst in the best specimens of those not sand-worn there is a definite varnish or glaze, as if the surface of the body had been heated sufficiently to raise its temperature just to the point of fusion, thus taking off the sharpness of, but not obliterating the lines of, demarcation between the fracture facets (Plate XX, Fig. 11), while in others this fusion of the surface has gone so far as to obliterate all the fracture marks and dividing ridges (Plate XX, Fig. 12). The large hanging drop form of the inner side of Mr. Dunn's button shape would be quite accounted for if the bleb were formed on the top, where it partially hardened, and the bubble would be attached to the sharp outer ridge, while when the bleb was below the surplus glass gravitating downwards would naturally collect where the loosely attached ring is found. (Plate XIX, Fig. 1)

This glaze more or less perfect is found, of course, upon some specimens of all the other forms, as well as the conical one. This theory also presents a very comprehensible reason why the patterns are so few and are so exactly duplicated.

The mode of formation of the dumb-bell and other allied shapes is one of the difficulties brought against the bubble theory. It can be asserted with the most perfect assurance, however, that this hypothesis affords an explanation, and, as far as I know, the only explanation, that will account for the curious fact that the two ends of the dumb-bells do not lie in the same plane, but are curved towards one another, the curvature being such as would naturally be caused by the convexity of a bubble, the shorter the dumb-bell or other long shape the greater the curve (Plate XX, Figs. 13 to 17).

Until the last few days I was of opinion that the facetted portion of the conical and dumb-bell forms were on the inner side of the sharp ridge, but I am now quite convinced that the large rounded disc on one side of the ridge is the hanging drop inside the bubble, while the facets and small flatter disc are towards the outside. In every case the curvature of the dumb-bell is towards the facetted surface (Plate XX, Fig. 17), and it is inconceivable that the dumb-bell should curve away from the bubble, and as the dumb-bells shown approach very closely the lens form (Plate XX, Figs. 13, 14 and 15), so I am convinced that it is from a body of that shape that our West Australian conical Australite has been produced, though why it should sometimes chip in this way and sometimes leave the body in the tabloid form, is not at present explainable.*

Our West Australian conical Australites, when they are found, have the apex of the cone pointing down and stuck in the sand or mud, thus furnishing a further reason for believing that the cones pointed outward in the bubbles.

I now thought that a most useful line of investigation would be to blow bubbles that would last long enough to allow the bleb to be photographed, and I wrote to *Nature*, asking for advice as to a material that could be used for this purpose. Professor Boys courteously gave me the recipe asked for, but in the meantime at Mr. Curtis' glass foundry they very kindly blew some glass bubbles for me, which gave me roughly the information that I required at the time (Plate XIX, Fig. 3), so I have never blown my bubbles with Professor Boys' material.

Professor Kerr Grant, of Adelaide University, seeing the answer to my enquiry in *Nature*, very thoughtfully sent me a copy of a paper he had read before the Royal Society of Victoria, in support of the contention that bubbles cannot possibly be formed from Obsidian, and that therefore these bodies must be of meteoric or extra terrestrial origin, giving many arguments in support of this contention.

The divers deductions different persons can draw from the same premises is a very interesting study. I took the liberty of writing to Professor Kerr Grant, criticising his paper, and in that communication each of his arguments was taken seriatim, and showed how, in my opinion, the conclusion to be deduced from his premises was exactly the opposite of that which he drew in support of his contention. I must apologise to Professor Kerr Grant for the liberty I took and am taking, but the episode was a most useful one to me, as it provided me with a series of arguments from which to start different lines of thought and investigation on which to build up my thesis. It put into my hands an able exposition of the foundations of the meteorite hypothesis, requiring demolition by the exponents of the bubble theory. I will now take the further liberty of using this paper of Professor Kerr Grant's, which I presume was sent to me for my instruction and my criticism, and elaborating from it my advanced arguments in support of the working hypothesis which I consider has all the evidence in its favour and has never been satisfactorily combatted. I trust that Professor Kerr Grant will not take anything I may say in my criticism of his arguments as in any way a personal matter. I only take his brochure as it is the fullest and most comprehensive statement in favour of the meteorite theory, by an authoritative expert, that I have read, and I have therefore used it as by showing the fallacy of his arguments I can most conveniently establish my own. I hope no one will think that I mean the slightest discourtesy to Professor Kerr Grant ; I simply state my reasons for my own personal beliefs, giving at the same time the meteorite arguments, I hope fairly and, as far as possible, in Professor Kerr Grant's own words. I then leave it to you and to others who may do me the honour of reading this paper to arrive at the truth.

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* Since reading the above, I have thought of an explanation that would account for all the many divergent modifications of the few typical shapes in which Australites occur. It appears to me to warrant further thought · in fact, I may say that several arguments in favour of it have presented themselves to my mind. Roughly, I may say that it is that on the surface of the molten glass, when it comes in contact with the air, a thin pellicle or scum forms, and the masses of gas on rising lift pieces of this skin of different sizes and shapes, according to the size and shape of the gas, and this dragging after of glass from their edges would form blebs on the summits of the bubbles, I hope in the near future to be allowed to read another paper on the subject, when I will be able to show you many reasons for believing this to be the true explanation.

As an argument against the possibility of the bubble theory, Professor Kerr Grant says :—

> " It is evident without exact investigation that one part of the interior (of a bubble) cannot be convex while another is concave. But as both the upper and lower surfaces of the obsidianites are invariably convex it is obvious that the attachment of the ' bleb ' to the bubble in the way imagined by Mr. Dunn is a physical impossibility."

As I have already said, I had then recently been able to get some glass bubbles blown with blebs on them ; some were blown so thin that they burst, but in every case the bleb was convex on the inside of the bubble as well as outside. (Plate XIX, Fig. 3). It may not unreasonably be suggested that the glass blebs had cooled and become too rigid to take the perfect shape of a normal bubble before the completion of its blowing. I therefore am hoping, when I am able to blow my new bubbles, that they will be in further support of this experiment. I also propose to endeavour to produce dumb-bells and others of those curious shapes that are so difficult to account for.

Again, Professor Kerr Grant shows by the aid of figures that obsidian bubbles cannot be formed that will float in air, nor exist even at our normal surface atmospheric pressure. Without answering his figures, I would reply that his contention is necessary for the understanding and support of the bubble theory. Several mathematical friends whom I have consulted, and to whom I have submitted Professor Kerr Grant's figures, have assured me that they saw no reason why bubbles might not be formed, and, provided they were thrown rapidly to a sufficient height into upper rarified atmosphere, they thought it quite possible that they could continue to exist there a long enough time to permit them to be transported to the positions in which they are found, if the conditions were such as I detailed to them. These conditions I will now explain to you. They consist of the determination of the locality of the origin of these bodies, and the method of their transport to the positions where they were deposited.

Of course, the first speculation that presented itself was to learn whither to look for their origin, if they were borne by the atmosphere and dropped where we find them.

I had much trouble in discovering any satisfactory information concerning the movements of the upper atmosphere, which I not unnaturally expected would be from east to west, viz.: in the opposite direction to the rotation of the globe. As I argued to myself;

> "Being somewhat outside the influence of the friction which would draw the lower atmosphere with the globe as it rotated, the outer atmosphere would tend to lag somewhat, remaining more stationary. In this way it might appear as if travelling in the opposite direction, viz.: from the east, and from the rate of rotation of the surface of the globe some 1,037 miles per hour even as if travelling very fast.

If the outer atmosphere only travelled 10 per cent. slower than the lower it would in effect be a wind of 104.2 miles per hour in the opposite direction at 10 miles above the surface of the globe.

I must record my great indebtedness to Mr. Cooke, the Government Astronomer, for getting me the latest information on the subject, viz.: Professor Hildebrand Hildebrandson's work, as the result of thirty years' observations on the movements of the upper cirrus clouds, which was the accepted authority, he informed me.

Professor Hildebrandson stated at the Southport meeting of the British Association in 1903:—

1st. That above the Thermic Equator and belt of calms there existed throughout the year a current from the east.

2nd. That above the trades an antitrade prevailed from the south-west in the Northern Hemisphere, and from the north-west in the southern.

3rd. That this antitrade did not pass the Polar limit of the trades, but deviated more to the right in the Northern Hemisphere, and to the left in the Southern, so as to become a current from the west over the crest of the barometric maximum of the tropics, where it descends to increase the trades.

Mr. Cooke informed me that the barometric maximum in Australia varies from about latitude 25° S. in winter to 35° S. in summer.

This, as I understand it, means that the upper cirrus clouds at the equator travel constantly from east to west, tending to diverge north or south, as the case might be, and at from 25° to 35° north or south turn towords the east, becoming south-west winds to the north and north-west winds to the south of the equator respectively, with a tendency to turn more towards the east in both cases.

Now, if this be true, and the statement regarding the velocity of this air current, which I have seen elsewhere affirmed to be from 60 to 80 miles per hour, be also true, it would quite account for the distribution of Australites and Billitonites, if they were derived from one or more of the numerous unexplored volcanoes of the East India Islands.

It would account for these bodies being restricted in their distribution to the small portions of the globe where they are found. It would account for their formation being spread over such a long period of time, as I think I have proved is certainly the case, from the late tertiaries even probably up to the present. It would explain why Australites are more numerous than Billitonites, as these volcanoes, mostly lying to the south of the Equator, more would naturally come south than would go north.

It would also account for so few being found within the tropic generally, as the perfect bubbles would not tend to drop so soon and the deformed ones would have dropped earlier, though the scarcity of population and the heavy rains may have something to do with it.

It is curious that the button form occurring with reasonable frequency in the Eastern States is not found in Western Australia as far as I know, and the tabloid form, which is one of the commonest here, is not figured in any plates that I have seen as occurring in the East to my recollection. (Compare Figs. 1 to 3 with Figs. 4 to 9, in Plate XXI.)

This would point probably to more than one source for their formation, or it may be that the Eastern form, which it is suggested by Mr. Dunn is represented with us by the conical one, has been the bleb of a more perfect or less fragile bubble.

As I will explain later, there are reasons why I cannot agree with Mr. Dunn that our conical form is derived from a form like the Eastern button, though they may have one resembling the conical that is so derived, as is well shown by comparing the picture of the Australite in Dr. Suess' paper with the Australite I show you (Plate XVIII, Figs. 3 and 4), you will notice the different size of the fracture facets and the different shapes of the portions of the bodies representing the inside of the bubble. I am of opinion that the apex of the West Australian conical Australite represents the outside surface of its bubble, while in the sections of buttons shown by Mr. Dunn the opposite is apparently the case, with their conical cores, of which Suess' illustration is one. In fact, on more mature consideration I am more and more convinced that the Eastern and Western Australites are of two types, and almost certainly are derived from different sources. The button form is the Eastern type, and the lens the Western. Apparently the former is produced from a more fluid and less viscid glass than the latter.

Professor Kerr Grant believes that we are driven, for the reasons he states, to fall back on an extra terrestrial source for the origin of these Australites, Billitonites, and Moldavites, and he explains their very local occurrence as being due to a small meteorite shower or possibly a recurrence of the same shower. Against this is :—

1st. The different compositon of Moldavites when compared with Australites and Billitonites. These could not, therefore, be from one shower nor a recurrence of the same. All Australites, moreover, as I think I have proved, are not contemporaneous.

2nd. Their different shapes. Australites are never found in the least resembling the shapeless Moldavites, specimens of which I have received recently from the Prague Museum. I have them here for your inspection (Plate XXI, Figs. 5 and 6). Moldavites do, however, sometimes take more definite forms when in shape they closely approach tabloid Australites (Plate XXI, Figs. 7 and 8).

3rd. All Australites and probably, judging from their identity of composition and from a paper I have read about them, all Billitonites consist of a very dark ferruginous glass, showing a remarkable uniformity of colour and appearance, whereas you have only to look at the few specimens of Moldavites that I am able to show you to recognise the entirely different quality of the glass of which they are composed, and the remarkable variability of its colour.

4th. Glass is very rare in meteorites, and there are no other known entirely glass ones to the best of my knowledge and belief.

5th. The world, for all we think it so big and important, is in reality a very small speck in space, and it is almost inconceivable that so small a meteorite stream should be passed through that it would not vastly more than cover the area of the globe, not to mention a small patch on its surface, such as the area where Moldavites occur, or even Australia.

A meteorite shower must surely fall, in any case, in the form of a band right across or round the world on account of the rotation of the globe, even if the band be a narrow one, though, of course, sporadic meteorites occur constantly quite irregularly.

I must here again emphatically draw attention to the different ages of Australites requiring the visit of more than one shower, and their practical restriction to Australia, and not even all of that, there being quite a wide belt of tropic between the Billitonites to the north and the Australites to the south.

Whilst, last and most particularly, meteorites never have any regular shape, and it would be at least curious and requiring a very precise explanation to account for such a very marked exception as Australites present, exhibiting as they do so few and such definite forms, and such remarkable uniformity in these forms.

I see in the *West Australian* report of Professor Ross's lecture to the Astronomical Society that "Meteorites are generally pointed, the pointed end having been downwards in the passage through the atmosphere. A number of ridges radiate only from the pointed part and are due to the flowing backward of the molten material." I base my statement on the following paragraph from "An Introduction to the Study of Meteorites," by L. Fletcher, Director of the Natural History Museum, South Kensington: "As picked up, complete and covered with crust, meteorites are not spherical, nor have they any definite shape; in fact, they are always irregular angular fragments such as would be obtained on breaking up a rock presenting no regularity of structure."

Again, another unanswerable argument against their meteoric origin is the occurrence of large Australites, quite normally shaped, consisting really of only a shell enclosing a beautiful glazed cavity, sometimes with a thin fragile septum (Plate XVIII, Figs. 1 and 2). The glazing of the interior of these cavities shows the surface produced by this glass when able to cool from a perfectly fused condition, without interference by air currents or other disturbing factors. Compare the outside surface of these Australites with the pictures of the inner surface of these hollow forms, and I think you must agree with me in inferring that the outside glaze has also been caused by at least a partial if not a perfect fusion. The shells are too thick to justify us in calling them bubbles, we can only call them hollow Australites or blebs of bubbles. These could surely not be imagined to have come from space nor to have been formed in our own atmosphere by any conceivable natural agency. They certainly do form a very convincing argument for the truth of Mr. Dunn's bubble theory, but, as I have said previously, it is not possible that these very large extremely fragile bodies can have lain on the surface of the ground for any great length of time, and most certainly not since tertiary or even early recent times.

It is very greatly to be regretted that in the opening of both these remarkable specimens no means were taken to ascertain what the contents had been. Possibly the smallest trace of water and watery vapour or one of the simplest gases, such as hydrogen or even helium, as the internal heat of a volcano producing a fluid glassy lava, must be very high, and at that temperature water would be very easily decomposed with the production of free hydrogen, while if volcanic action is associated with radium, as some seem to believe, that would account for the presence of helium. In any case, however one would expect the pressure to be a minus one.

The next argument brought forward is, to my mind, the strongest that I have heard against the meteorite theory. Professor Kerr Grant says :—

> "The average velocity of meteors which enter the atmosphere may be taken as about forty miles per second. If only one per cent. of the energy which such meteors possess were, under the influence of the air friction, converted into heat and retained by the body it would probably be sufficient to raise the substance of an obsidianite to the melting point and render it completely liquid. The melting point of the material and its specific heat have been determined in the Physical Laboratory, Melbourne, as 1,324° C. and .21 respectively. The remarkable homogeneous quality of the glass of which obsidianites are composed renders it certain that they have, prior to assuming their present form, been fused throughout."

When a meteorite enters our atmosphere from space it is generally travelling with such a velocity that, even at one hundred miles above the earth, it may already have produced such friction as to have become heated so as to glow and become visible. Small siderites have fused and been converted before they reach the globe into the microscopic so-called "cosmic dust," consisting of minute metallic spheres or shot-like bodies, found on the snow in arctic regions, and on the bottom of the profoundest depths of the oceans.

It is only masses of considerable size, or fragments of such masses, that are ever found as distinguishable meteorites. I have never heard of siderites being found so small as to be in any way comparable to the average size of Australites, not to speak of the smaller ones.*

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* It should be said here that meteorites meeting the earth in its flight may travel considerably more than 40 miles per second. Those, however, travelling in the same direction only a little faster that overtake it may be effectively travelling through the atmosphere at only a mile or two per second.

For one of these curious glass bodies that fall to the earth, there must be millions of falling stars, and yet these small bodies are never found, and they would be just as easily found as Australites or Billitonites. Observations show that a man watching the sky under favourable circumstances would if he kept his eyes fixed on one spot of the heavens see from five to sixty nine falling stars per hour or an average of over eleven throughout the year. Altogether it is believed from several computations that from 15 to 25 millions of small meteorites reach the earth as falling stars every day. This is counting only visible meteorites and they are not all glowing and visible so there can be no questioning their much greater profusion than Australites.

Siderites require some 2,912 F. of heat to fuse them; these glass bombs would require only 2,383 F. (which is the same as 1,324 C.); yet I have here as you can see a perfectly shaped lens form Australite weighing just 4.9 grains which has a sharp straight edge all round and shows no sign of distortion as it must if it had reached the globe even very slightly plastic (Plate XVI. Fig. 5.)

The temperature necessary to produce a fluid glassy lava denotes a very hot volcano for the production of these bodies. From what I read, the temperature of Vesuvius which produces a plastic crystalline lava is very little more than half that stated by Professor Kerr Grant to be necessary to fuse Australites.

Volcanoes producing glass are rare in this world; those producing stony lavas are common. It is curious that the only lava meteorites reaching us should be glassy though plutonic aerolites often occur.

I cannot understand why Professor Kerr Grant should take the trouble to consider rotation forms as accounting for the Australite shapes as a glass meteorite could never so fuse from the friction of the atmosphere as to become a mass of molten glass; if it did it would be instantly dispersed into microscopic dust by the opposing air. If it did become as suddenly heated as would be the case from air friction at the rate of progression of a meteorite it would tend rather to decrepitate or chip than fuse and the time occupied by its passage of the whole atmosphere would be too short to permit any but the smallest to be heated to such a temperature all through as to fuse it. In any case there would be no time for them to take rotation forms and cool again before reaching the earth.

Without any question these bodies have been cold except perhaps their very surface at the time they struck the ground or they must have been distorted.

When a siderite such as an ordinary falling star which is believed to enter our atmosphere on an average about the size of a pea or say about the same size as this small Australite of mine, fuses from atmospheric friction caused by its rapid flight, it has been pointed out to me that it must be the outside that first heats up, glows and fuses, this fused coating being instantly —in fact perfectly automatically wiped off by the air through which it is rushing thus exposing another surface to heat glow and fuse this being removed in the same way; a still further surface is exposed and so on till the whole is gone; thus it would leave a meteor-like tail of dust in its track which in due time would fall to the earth as cosmic dust of which many tons are believed to be added to the world every year.

This view is supported by the glazed surface on some of the siderites shown.

According to the latest theory that has been brought forward to account for the original formation of the world it is held to be almost entirely from these meteoric bodies, large and small, stony and metallic, that the globe as we know it has been built up, and indeed is still being built up and yet these curious regular bodies of uniform shapes are absolutely restricted to these rare and unique glass bombs and to quite small and detached portions of the surface of the globe.

With regard to the rotation form on which Professor Kerr Grant lays such stress he says:—

> "The forms which a mass of liquid in motion is capable of assuming have been the subject of discussion by many eminent mathematicians from the time of Newton to the present day. Neglecting the effect of air resistance on the surface, it has been shown that the following forms are possible:—
>
> 1. The Sphere possible only when there is no rotation.
> 2. The Oblate Spheroid—stable at low speeds of rotation.
> 3. The Prolate Spheroid—stable, if at all, only at high speeds of rotation.
> 4. The Apioid, or pear-shaped figure of revolution.
> 5. The Dumb-bell or hour-glass figure of revolution.
>
> It is remarkable that all these forms, if we neglect secondary features, are comprised among those assumed by obsidianites. The occurrence of cigar-shaped and dumb bell shaped figures is of particular interest, since the stability of these types is still of dispute among mathematicians." (Plate XXIII.)

Of course if one neglects the effect of air reistanoee on the surface and ignores secondary features which are both very important and suppose a molten mass of glass revolving in and rushing through the air which is a physical impossibility one can produce almost anything one desires in one's own imagination.

Professor Kerr Grant does not explain why these rotation bodies are never formed from siderites.

If 1 per cent. of its latent energy when converted into heat would suffice to fuse an Australite it would require less than 1½ per cent. of the energy latent in a siderite to fuse it. Thus the heat generated by the friction of its flight. at least in the upper portion of the atmosphere would be amply sufficient to reduce it to a molten condition even though its lessened rapidity as it approached the globe due to the brake power exerted by the friction of the opposing air were to permit it to become plastic again. This of course is arguing on the supposition that Professor Kerr Grant's premise is correct which as I have just stated I believe it is not.

We never find nor hear of anyone else finding siderites even resembling these shapeless Moldavites; they always reach us as definite fragments of larger bodies at least as far as I have been able to ascertain though their surface may appear to have been recently fused or their mass split up. The same may be said of stony meteorites or aerolites as they are called.

A siderite would conduct heat into its interior much more readily than a glass meteorite though still not well. The latter would tend rather to decrepitate or flake off from the surface, which may account for the curious markings on these bodies, which have been so minutely and laboriously described.

I have described Australites as having a fused surface when newly fallen and yet maintain here that if suddenly heated they would chip rather than melt. This is perfectly correct. Australites falling as the result of the collapse of their bubbles would start to fall slowly and increase their pace gradually; thus the heat would increase also slowly and even the outside would never become very much hotter than just sufficient to fuse it. I should say even that they might chip in places while fusing surface as a whole hence the markings as I said before.

If they were meteorites they would probably start, according to Professor Kerr Grant, at a velocity of 40 miles per second, which would involve a very sudden heating indeed, and they would be far more likely to flake than fuse. This is in entire support of my description of the disintegration of a falling star, the small ones fuse from the surface inwards, as there would be no great distance for the heat to diffuse into the centre the body would rise in temperature almost equally throughout and thus the surface would be able to melt and be wiped off without the body cracking, so they are dissipated to dust. The large ones may fuse on the surface and remain whole or may break up, as would be determined by their structures, as from their size the heat would diffuse more slowly.

The time occupied by the passage of a meteorite through the air, even though the heat generated on the surface by the friction were perfectly conducted into the centre of the mass and so none lost, would not be sufficient to permit enough to be generated to entirely fuse a comparatively small body.

Starting at 40 miles per second, as Professor Kerr Grant states, or even at 25 miles per second as, I am informed by

Professor Ross is a fair average, estimating our effective atmosphere as 150 miles in depth and supposing the friction slowed the rate to nothing on reaching the earth, it would travel at an average pace of 20 miles per second in the one case, and 12½ in the other, and so would take exactly either 7½ seconds or 12 seconds in its flight.*

This seems to me scarcely enough to fuse this Australite (Plate XVIII, Fig. 6), weighing a little over a quarter of a pound, not to mention shaping it to a regular rotation form and cooling it again, yet at the same time it surely would be more than enough to disintegrate this small one of 4.9 grains (Plate XVIII, Fig. 5), with a fusion point so much lower than that of siderites.

I have just heard from Mr. J. B. Scrivener, the Geologist to the Federated Malay States, that in the Singapore Museum are two obsidianites weighing respectively 11¼ and 14¾ oz. avoirdupois. He does not describe their shape, and is unable to find any record of their origin.

The surface of the large one, however, if it had taken such a flight, must have chipped and chipped till it would have been very unlike the very fairly smooth object we see here. I think we can certainly infer from this that it is not a meteorite.

This large Australite was found by Sir John Forrest in the interior of Western Australia when he was on one of his overland trips, and I have to thank Mr. Woodward, of the Museum, very much for his kindness in allowing me to exhibit this valuable specimen.

I think it may very pertinently be asked why none of these glowing falling stars reach us as metallic Australites, or even Moldavites. I refer, of course, to their shapes. Sir G. H. Darwin says, in his book on tides, that they can only be produced in the absence of external gravity. Anyway, the forms in which Australites are found are not rotation forms in which the upper and lower hemispheres must necessarily be symmetrical and equal, and thus the equator equidistant from the poles and rounded, not sharp. Even the lens form is not symmetrical above and below; it has a sharp edge round it which is not a true equator. The ordinary conical form is no more symmetrical than the button shape found in the Eastern States, from which Mr. Dunn supposes it to be derived.

I regret I cannot altogether agree with Mr. Dunn in this, as the fracture facets round the cone reach much further towards the smaller disc than would be possible if they were derived from the button form, which exhibits such a remarkable hanging drop inside the bubble, while in the conical it is the outer disc that is rather flatter and less hemispherical than the inner, and the apex of the cone must have pointed outwards in the latter and inwards in the former, though this is only apparently so, as if the hanging drop of the button form is regarded as represented by the comparatively small curved inner surface of the Western Australian form the two cones are comparable and both point towards the outside of the bubble, the fracture facets sloping in that direction in both (Plate XVIII, Figs. 3 and 4). Another reason is that the button form is curiously absent with us. If our conical shape, which is the commonest found over here, were derived from a button form, some of the latter must have been found in Western Australia.

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* Since writing this paper I learn that siderites of quite small size are found, in fact they are not uncommon, but they are shapeless angular fragments and their number by no means corresponds with that of falling stars, as stated above. Very small aerolites are also found, and the same remarks apply.

As I have said before, it is almost certain that the type from which these Western Australian conical forms have been derived is the tabloid and the obsidian forming them has been less fluid than that producing the button form.

There may be, of course, a form of similar shape to the conical that is the core of the button Australite. The large Australite I have shown you seems to answer to Mr. Dunn's description, but this may be due to sand friction or extra fusion of its surface from its bubble having burst at a greater height in the atmosphere. There is no question, however, that the Australite figured by Dr. Suess is the centre of a button form with the ring detached.

It would be interesting to have it explained how a hollow conical shaped body, with moreover a septum in it, or even without the septum, could be accounted for as a rotation body.

The dumb-bell form, which in no way resembles an hour glass as it should, according to the rotation theory would consist of two spheres revolving on their own axes, as well as round each other, so closely as to raise a tidal wave of molten matter sufficiently high to join them, is quite inexplicable in this way, as the two ends are themselves not symmetrical, nor do they lie in relation to each other in the same plane, but are inclined towards one surface, as you will see quite clearly in these specimens. Even if they be regarded as simple rotation bodies of unstable form their want of symmetry and deviation from a true plain would quite put them out of court.

I must express my conviction, however, that the latter is simply a way of begging the question regarding them as, when a prolate spheroid (which in this case would have the poles in the centre of its length) tends to become dumb bell in form from increased rapidity of rotation it really means that the two ends are concentrating to form two globular bodies tending to become dissociated and revolving separately as two distinct spheres, and the same may be said of the apioid form, which is really a globe and a satellite.

The instability of these forms surely depends on the tendency of the two ends to become dissociated entirely from each other and to fly apart on account of the preponderance of the centrifugal force unless the rapidity of revolution is exactly correctly balanced. This apparently never occurs in nature, as twin stars or globes and satellites are always separate and never attached to each other. They either unite into one globe or become stable by separating to a certain distance from each other, which is capable of calculation.

The rotation explanation of Australite shape formation does not take into consideration the, to me, quite self-evident fact that if such a rotation body, however perfect its shape and motion, struck the earth on the softest imaginable spot whilst in the most slightly plastic condition, even if it struck it exactly truly plumb to the surface, it must afterwards much more resemble the Moldavites exhibited than the rigid mathematical shapes in which we find Australites showing no faintest sign of impact.

Professor Kerr Grant says that he thinks he has seen signs of impact on one or two obsidianites. If his explanation were correct it would not be one or two questionably, but every one very unquestionably, that as one might say would be all sign of impact and have no other shape.

I make the suggestion, with some diffidence, but perhaps these Moldavites were endeavouring to become true rotation forms when they struck.

My complete hypothesis founded on the premises and arguments I have laid before you in this address, seems to be that somewhere in the East India Islands, stretching along the whole of the north of Australia, is a volcano, or are volcanoes (it is not necessary to suppose that the volcano that produced the Tertiary Australites is necessarily the same as has produced and is producing the modern ones, nor that all the modern ones are produced by one and the same volcano) with craters containing a thoroughly fused plastic glassy lava of the correct composition, wherein bubbles of highly superheated steam or other gas rise with considerable force, carrying with them a thin pellicle or bubble of the lava with a bleb attached. These being shot upwards by the explosive force of emergence, combined with the rush of the large vertical column of intensely heated vapour over the cauldron, reach a height of several miles, and thus are carried above the lower atmospheric stratum, with its varying eddies, governed by the irregularities of the surface of the globe, and its unequal heating, and enter the tornado-like current of highly rarified air of the central stratum, in which also the highest cirrus clouds are situated, which moves continuously and with great velocity in a certain definite direction from one years' end to the other, viz.: first towards the west then south or north, as the case may be, then south-east or north-east, and finally east, by which within two or three days at the outside they are transported till vertically over the continent of Australia, if Australites, or correspondingly north if Billitonites. By this time the bubbles having descended slowly and steadily into the dense lower atmosphere are crushed and their brittle thin globes chipped off the more resistant blebs in varying manners according to size and shape.

The blebs drop to the earth at first slowly, then more rapidly, becoming gradually heated on the surface by the friction of the air in their passage, so that it fuses and they become covered with a thin glaze. That this is possible, even considering the comparatively high fusion temperature of their glass, is shown by siderites being found with their surface fused.

These latter bodies conduct the heat from their surface only imperfectly, and thus would retain the cold of space in their centres, even when a thin layer of the surface was heated sufficiently to fuse and produce the glaze you see here. Their fusion temperature is higher, but they have a much longer and more rapid flight. Then, if they chance to fall on some soft spot on the globe, such as sand or mud, they will be preserved as we find them.

So many of my correspondents having expressed so strongly their adherence to the meteorite hypothesis, and their opinions as to the impossibility of Mr. Dunn's proposition, I have felt compelled to endeavour to show the utter futility of each and every argument adduced to support the idea of these bodies coming from extra terrestial sources. If I have been partially successful in this and in adding any extra links to the bubble chain of evidence I shall feel amply rewarded.

I hope that if any have opinions, facts or arguments upon this subject, either in favour of or against the hypothesis now put forward, you will give us the benefit of them. If in agreement, I welcome you; if in friendly opposition I welcome you scarcely less, almost more, in fact, as there is nothing so stimulating and supporting as a sound strong constitutional opposition.

Finally, I would wish to express my obligation to many friends for information and advice, to the Director of the Prague Museum, for his exceedingly well-timed gift of Moldavites; to Mr. Simpson, to Professor Ross and others for papers and specimens for exhibition this evening; to the Minister for Mines of Victoria, for permission to use and the loan of some of the plates belonging to his department; and to Mr. Irwin, of the Geological Department, for much patience and trouble given to the photographing of my type specimens, so as to exhibit the points requiring illustration.

LIST OF LOCALITIES OF AUSTRALITES.

Queensland.

Central District
Newinga Resumption, between Thallon and Talwood
West of Blackbutt

New South Wales.

Between Murray and Darling Rivers
Boggabii
S. of Liston
Liverpool
Broken Hill
Cobar District
Delegete
Major's Creek (Braidwood)
Mt. Oxley
Thackeringa
Turnberumba
Turon
Uralla

Victoria.

Acheron River
Ararat
Balmoral
Ballarat
Beechworth
Bolwarrah
Brim Plain
Byaduk
Condah
Daylesford
Edenhope
Glenelg River
Grassmere
Hamilton
Harrow
Hard Hills (Buninyong)
Heidelberg
Horsham
Lake Albamtya
Mepunga
Mt. Eccles
Mt. Elephant
Mt. William
Napoleons
Nerring
Peterborough
Portland
Raglan
Retreat Creek (Ingleby)
Rokewood
Smythesdale
Talbot
The Mallee
The Wannon
Warnambool
Wimmera

Tasmania.

Weldborough
Fossil Creek—Main Creek
Springfield, nr. Scortsdale
St. Leonards
Cox Bight
Middleton Creek, Long Plain
St. Helens
Norfolk Range
Schonten Main
Tallywong Creek, Weldborough
Hunt P.A. Mine, Derwent Creek
Thureau's Deep Lead Mine, St. Helens

TASMANIA (Continued).

Supply Creek, River Tamar
Pioneer Tin Mine
Ember Creek, Gladstone
Wyniford River
Moorina
Camden Plain, Mt. Barrow
Lisle Gold Diggings
Back Creek, Lefroy
Thomas Plains
Smith's Creek ,Long Plain
Sandy Creek, Bootyalla
Gladstone, between Scotia and Lochaber mines
New Banca Mine, Bootyalla
Campbell's Creek, Gladstone
Purdin Mine, Gladstone
Black Creek, Brancholm
Tarman River drift, Humskirk

SOUTH AUSTRALIA.

Berksgate Range
Central Australia
Charlotte Waters
Everard and Fraser Ranges
Gawler
Great Victoria Desert
Kangaroo Island
Lake Eyre
Macdonnell Ranges
Mt. Squires
Stevenson River
Stuart's Creek

WESTERN AUSTRALIA.

Turkey Creek
Wodgina
Mt. Bates
Kimberley Range
Princess Range
Sir Samuel
Edjudina
Linden
Tevilla
Yilgangin
Kookynie
Menzies
Mt. Margaret
Yarri
Kurnalpi
Bulong
Kanowna
Kalgoorlie
Coolgardie
Slate Well
Lake Lefroy
Lake Cowan
Nullarbor Plains
Esperance
90 m. N.W. of Esperance
Israelite Bay
Bremer Bay
Williams
Kokerbie
Koorijin
Albany
Salt Water River
Katanning, 25 m. E.

BILLITONITES.

Billiton
Mt. Moeriah
Djapara, Java
Pleiari, Tamah Land
Sungei Riam, Tanah Land
Bunguran
Blat and Gabang Valleys, Pahang
Gemas and Sungei Triang, Negri Sembilan
Sudu Seremban, Negri Sembilan
Kuala Kubn, Selangor
Sungei Lembing, Kuanian Patang

TABLE OF ANALYSES.

	AUSTRALITES.									BILLITON-ITES.		MOLDAVITES.					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
SiO$_2$	72.39	76.25	77.72	71.22	70.62	71.65	64.68	69.8	73.59	70.92	71.14	77.60	82.28	77.75	77.96	82.68	78.61
TiO$_2$	.76	.65	.86		.9			.8	.7								
Al$_2$Os.....	13.21	11.3	9.97	13.52	13.48	11.96	16.8	15.02	12.35	21.2	11.99	12.78	10.08	12.9	12.2	9.56	12.01
Fe O$_3$	.42	.35	.32	.77	.85	6.62	6.57	.40	.38	1.07		2.05			.14		.16
FeO	4.48	3.88	3.75	5.3	4.44	nd	1.01	4.65	3.79	5.42	5.29	1.45	2.03	2.6	3.36	1.13	3.06
MgO	1.87	1.48	1.57	2.38	2.42	2.09	2.5	2.47	1.8	2.61	2.38	1.15	.98	.22	1.48	1.52	1.29
CaO	3.71	2.6	2.4	3.52	3.09	3.03	3.88	3.2	3.76	3.78	2.84	1.26	2.24	3.05	1.94	2.06	1.62
Na$_2$O	1.54	1.23	1.29	1.48	1.27	1.76	tr	1.29	1.03	2.46	2.45	.78	2.8	.26	.61	.63	.44
K$_2$O	1.92	1.82	1.96	2.28	2.22	2.4	4.01	2.56	1.93	2.49	2.76	2.78	2.2	2.58	2.7	2.28	3.06
N$_2$O ...	+.11	+.32	+.15		+.01			+nd	+ 27								
	.02	—.02	—.04		—.06			—nd	—.53								
CO$_2$																	
P$_2$O$_5$																	
MnO	.05	.06	tr	.28	.42	.16	.2	.18	.15	.41	.32				.1	.18	.11
Li$_2$O	s tr	s tr	s tr		s tr			s tr									
SrO									f tr								
BaO									f tr								
Cl$_2$.......					tr												
SO$_3$					tr												
Cr$_2$O$_3$.....																	
NiO......	.06	.03	tr		tr												
CoO	tr		tr		tr												
ZrO									.01								
Loss on ignition													.06	.1			
Sp. Gr. ...	2.427	2.398	2.385	2.433	2.454	2.47		2.454	2.428	2.447	2.44						
Sp. Gr. of others ..										2.503 2.445 2.464	2.42 2.454 2.452	2.303 2.333 2.359 2.321 2.347	2.304 2.338 2.360 2.323 2.348	2.305 2.342 2.360 2.326 2.354	2.309 2.352 2.364 2.331 2.357	2.325 2.354 2.347 2.339	2.326 2.356 2.321 2.346

1	A	Mt. Elephant	V.	G. Ampt, 1908
2	A	Hamilton	V.	Do.
3	A	Peake Station, Nr. Lake Eyre	S.A.	Do.
4	A	Between Everard Range and Fraser Range (Jahrb dkk. geol. Reichsaust Vienna, 1900, Vol. 2) ½	S.A.	C. V. John, 1900
5	A	Coolgardie (Records of Geol. Survey of Vic., Vol. ii, Pt. 4, 1908, p. 205)	W.A.	P. G. W. Bayly
6	A	Kalgoorlie	W.A.	E. S. Simpson, 1902
7	A	Uralla (Proc. Roy. Soc. of Vic., Vol. xi, N.S., Pt. 1, p. 30)	N.S.W.	J. C. H. Mingaye, 1897
8	A	From Upper Weld Report of Sec. for Mines, Tas., 1905, p. 21)	Tas.	W. F. Hillebrand, 1908
9	A	Pieman (Report of Sec. for Mines, Tas., 1905, p. 21)	Tas.	Do.
10	B	Tebrung	Dendang	C. V. John
11	B	Lura Mign	Dendang	Dr. Brunck
12	M	Radoneilitz, Light Brown	Nr. Budweis	C. V. John
13	M	Do. Light Green	Do.	Do.
14	M	Do. Dark Green	Do.	Do.
15	M	Tribitsch		Do.
16	M	Budweis, Light Green		Do.
17	M	Tribitsch		Do.

THE ONYCHOPHORA OF WESTERN AUSTRALIA. By W. J. DAKIN, D.Sc., F.L.S., F.Z.S.‡ (Read August 12th, 1913.)

Three species of this most interesting group of invertebrates have been described for Western Australia, namely—

I. *Peripatus Leuckarti*, var. *occidentalis*, syn. *Peripatoides occidentalis.*
II. *Peripatoides gilesii*, Spencer.
III. *Peripatoides woodwardi*, Bouvier.

Of these three species, *Peripatoides occidentalis* was the first to be made known. The species was described by Fletcher, from specimens collected by a Mr. Lea at Bridgetown several years ago (Proc. Linn. Soc. N.S.W., 1895 (2), 10). The diagnosis reads as follows: "*P. Leuckarti*, Säng, var. *occidentalis*, var. nov. With 15 pairs of walking legs; outer jaw blades without an accessory tooth." Beyond a brief reference to the colour, no description was given, and, unfortunately, no figures accompanied the paper. Several years after this date, specimens of another Peripatus were collected in W.A., and a number of individuals from Armadale were sent by Mr. H. M. Giles to Professor Baldwin Spencer. Spencer considered these specimens to belong to a new species and in a short paper read September, 1908, but not published until March, 1909, named the species *Peripatoides gilesii*, after the collector.*

In the year 1905, that is to say two years before the specimens were sent by Giles to Spencer, the German expedition of Michaelsen and Hartmeyer captured a number of Peripatus at Lion Mill, in the Darling Range. These specimens were sent to Bouvier, and his description, with an account of the anatomy, was published in the reports of the expedition in 1909.† Bouvier named the species *Peripatoides woodwardi.* The appearance of both the papers of Spencer and Bouvier in the same year precluded either worker from seeing the publication of the other.

After consulting both these papers in order to name certain specimens captured in almost the same district as the above, it seemed probable to me that both *Peripatoides gilesii* and *Peripatoides woodwardi* were one and the same. Further investigation has made this probability an actual fact.

My first specimens were collected at a spot not far from Mundaring Weir. The animals are to be found under small logs, and broken branches during the winter and spring months. These specimens from Mundaring agreed with Bouvier's description of *Peripatoides woodwardi.* In order to be more certain of their relation to *Peripatoides gilesii*, I asked Professor Spencer for the loan of the type specimens of that species, and he very kindly sent these, together with a microscopic preparation of the jaws.

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* Proc. Royal Soc. Victoria, Vol. XXI (New Series), Part II, 1909

† Die Fauna Sudwest Australiens. Band 1 Jena 1908-9.

DIMENSIONS. According to Bouvier, the length of his specimens varied from 10.5 mm. to 21 mm. This is stated by him to be almost the size of *Peripatoides orientalis* and a little larger than *Peripatoides occidentalis*.

Spencer's specimens of *P. gilesii* measured 22 mm., 25 mm., and 27 mm., respectively. The discrepancy in size means nothing, for in Bouvier's case the individuals were preserved and contracted. My specimens from Mundaring Weir ranged in size from 12 mm. to 34 mm. The length of 34 mm. was that of the largest when outstretched and walking. On being touched it contracted to 28-30 mm., and on fixation it diminished still further to about 22 mm. It is obvious, therefore, that one must be careful in deducing any differences from dimensions.

COLOUR.—The colour of the Mundaring Weir specimens agrees with that of the Peripatoides described by Bouvier, and Spencer's description is also similar.

MANDIBLES. The mandibles are accounted as one of the chief diagnostic features of the species *P. gilesii*. According to Spencer, the first jaw is simple in all specimens, without any accessory tooth. The second jaw has four clearly marked and one minute accessory tooth. Bouvier states that " Les mandibules sont depourvues de dents accessoires sur leur lame externe, comme dans les *Peripatoides Suteri*, *P. Novae Zeylandiae* et *occidentalis*, et contrairement a ce que l'on observe dans le *Peripatoides orientalis* ; leur lame interne presente 5 dents accessoires."

There is absolutely no difference between the jaws of Spencer's specimens, those described by Bouvier, and my specimens from Mundaring Weir.

The description of the mandibles given by Bouvier is not quite correct, for in some specimens the number of accessory teeth is more than five.

LEGS.—The number of claw-bearing legs is perhaps the most important character in the diagnosis of the species *P. gilesii* and *P. woodwardi*. Both Spencer and Bouvier state that the number suffices to distinguish their species from all other Australian forms except *Peripatoides Suteri*. They both, however, give the same number, sixteen! Thus so far as the supposed characteristic features are concerned, the specimens of Spencer and Bouvier are identical. Spencer's paper was published some months before that of Bouvier and consequently the name *P. woodwardi* must be rescinded. The Peripatus of the Darling Range, recorded from Armadale, Lion Mill, Mundaring Weir, etc., is *Peripatoides gilesii*, Spencer.

Specimens of Peripatus from Jarrahwood, in the south, have been kindly collected for me by Mr. L. le Souef. These specimens I had fully expected to be like those from the Darling Ranges. In fact, it would not have been surprising to me if the species named *P. occidentalis* by Fletcher in 1895 had also turned out to be another synonym. This is not the case, for all the specimens forwarded agreed in possessing fifteen pairs of legs only and thus differed from the form described above. Thus after nineteen years we have another record of the species *Peripatoides occidentalis.*

There is no doubt, therefore, that there are two species of Peripatoides in West Australia. *P. occidentalis* resembles *P. gilesii* very closely in colour and the same variety occurs. Two series of individuals are common, a group in which brown-red predominates, and a group in which a green-black shade is the dominant colour. At present further investigations are being made and it will probably be found that the two Western Australian members of the Onychophora are closely related to one another—perhaps only varieties of the same species.

AQUATIC ANIMALS FROM HANNAN'S LAKE, KALGOORLIE. By W. B. ALEXANDER, M.A. (Read September 9th, 1913.)

On August 9th, 1913, I visited Hannan's Lake, my special object being to look for Phyllopods, of which several species have been obtained previously in that neighbourhood.

Close to Lakeside station I found a small pond which appeared to be supplied from a pipe, presumably with water from Mundaring Weir. The water was very turbid owing to the breeze which was blowing creating waves, which stirred up the muddy bottom. In the pond I observed numerous tadpoles, and obtained two specimens of a species of Estheria* and ten of *Apus australiensis*, Spencer and Hall (nine females and one male).

A sample of the water which I obtained has been analysed for me by Mr. E. S. Simpson, Chemist and Assayer to the Geological Survey, to whose kindness I am much indebted. He reports that it is perfectly fresh potable water, the total solids contained being only 0.05 per cent. and the chlorine only 0.01 per cent.

In the bed of Hannan's Lake itself water was standing in a number of depressions round the old workings of the Hannan's Public Crushing Battery. In the largest of these was a considerable pond whose water appeared to be four or five feet deep, the depression in which it was standing being largely artificial.

In this pond I noticed a few large tadpoles, and obtained the larva of a dragon-fly. The water was teeming with a small brown Cladoceran, and I captured a male and a female of an Apus, which struck me at once as being different from those I had just obtained from the other pond. They proved to be examples of *Apus gracilis*, Wolf, the only previously known specimens of which were obtained by Drs. Michaelsen and Hartmeyer on July 1st, 1905, in a pond of slightly saline water in a dam near Hannan's Lake.† Dr. E. Wolf states that the water was sufficiently fresh to be used for cattle to drink.

He remarks, "This record is certainly remarkable, since it was not previously known that any species of Apus could live in saline water." He also expresses surprise at the occurrence of the animals in the winter, since in most localities they prefer warm water.

As to the second point, it is obvious that Apus could hardly exist in Australia at all, unless it took advantage of the winter rains, since it appears to be confined to small ponds which under natural conditions are not present in the summer.

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* Since named *Cyzicus rufa*, Dakin. (See P.Z.S. 1914 II p, 301).

† There are specimens in the W.A. Museum from Lake Violet, Wiluna.

The pond in which I obtained my specimens seems to have been salter than that from which the German naturalists obtained theirs, since Mr. Simpson states that the water is too saline for even stock to drink. The figures given are: total solids 1.40 per cent., chlorine 0.69 per cent. (Cf. sea water: total soldis 3.5 per cent.)

In a third very salt pond on the far side of the Hannans' Battery workings I collected numbers of two species of water-beetles,* but saw no other animals. The water from this pond contained 9.03 per cent. total solids and 5.06 per cent. chlorine. The samples I collected were too small for complete analysis, but the following results of an analysis of Hannan's Lake water, made by Mr. Simpson in 1899 give an idea of the relative quantities of different salts in the waters of this lake:—

Potassium chloride	strong trace	
Sodium chloride	12.837	per cent.
Magnesium chloride	1.926	,,
Magnesium sulphate	.492	,,
Calcium sulphate	.398	,,
Calcium carbonate	.005	,,
Silica	.005	,,
Alumina	.004	,,
Total solids	15.667	,,
Total chlorine	9.213	,,

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* *Necterosoma regulare* Sharp and *Berosus* sp.

THE HISTORY OF ZOOLOGY IN WESTERN AUSTRALIA. PART I.—DISCOVERIES IN THE 17TH CENTURY. By W. B. ALEXANDER,* M.A. (Read September 9th, 1913.)

Some years ago the Mueller Botanic Society devoted considerable attention to ascertaining the history of discoveries concerning the flora of this State. Prof. Diels, in his excellent work, "Die Pflanzenweld von West-Australia," has also devoted a chapter to the work of the early botanists in this part of the world. But so far as I am aware no one has previously endeavoured to bring together the records concerning our fauna which are contained in the numerous volumes published by the explorers of the West Australian coastline previous to the foundation of the Swan River Colony.

In this first portion of my paper I have collected the meagre observations on animals which were made by those Dutch navigators who touched upon our coastline either accidentally or by design. The only considerable information on the subject, however, in the period under consideration is contained in the admirable journal of the first Englishman who set foot in Australia, Capt. William Dampier.

The first account to which I must refer is contained in the Decades of Peter Martyr, and relates to the voyage of a Spaniard, Diego de Lepe, and to discoveries made by him in 1499. In that year he visited a country containing "trees of such bigness that sixteen men joining hands together and standing in compass can scarcely embrace some of them. Among these trees is found that monstrous beast with a snout like a fox, a tail like a marmoset, ears like a bat, hands like a man, and feet like an ape, bearing her whelps about with her in an outward belly, much like unto a great bag or purse. The dead carcase of this beast you saw with me and turned it over and over with your own hands, marvelling at that new belly and wonderful provision of Nature. They say it is known by experience that she never letteth her whelps go out of that purse except it be either to play or suck until such time that they be able to get their living by themselves."

Mr. E. A. Petherick, the Commonwealth Archivist, who first drew attention to this passage, believes that it relates to the karri forests of South West Australia, and that the animal described is a kangaroo. There is other evidence to support the view that de Lepe did reach South West Australia, but it appears to me that the description is that of an opossum, and not of a kangaroo, and therefore the animal was more likely to have been met with in America. The following statements about the animal would fit an opossum much better than a kangaroo: it had a tail like a marmoset, hands like a man, and feet like an ape (*i.e.*, prehensile), moreover the whelps are referred to in the plural, which would rule out both the kangaroo and the Australian opossum, but would fit the American opossum.

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* Biologist to the Western Australian Museum.

The first undoubted record of Australian animals is contained in the letter of Skipper Haevick Claeszoon van Hillegom to the manager of the Dutch East India Company, dated June 24, 1618, in which he gives his report of the voyage of his ship, the "Seewolf," from the Cape of Good Hope to Jacatra, in Java. He says: "On the 5th of May (1618) we got into latitude 28° 26′ South [a little north of Geraldton], where we saw numbers of birds, many of which seemed to be land-birds, such as a white tern and a few ternlets, so that I surmised we were near the land. . . . On the 11th do. we saw land in 21° 20′ S. Lat. [N.W. Cape]; we saw a good deal of seaweed floating about, and observed land-birds up to the 16th degree, both of these being signs of the proximity of the mainland."

From "The Book of Despatches from Batavia" we learn that "in the year 1628 the great south land was accidentally discovered on the north side in the latitude of 21° S. [N.W. Cape] by the ship 'Vianen,' homeward bound from India [Java]; when they coasted about 50 [Dutch, 200 English] miles without gaining any particular knowledge of this great country, only observing a foul and barren shore, green fields, and very wild, black, barbarous inhabitants."

Having noted this first record of the Australian aboriginal I shall omit the references to the lord of creation and his habits contained in subsequent accounts, and confine myself to the humbler members of the Western Australian fauna. Perhaps some other member of the Society will devote himself to bringing together the very considerable amount of anthropological and ethnological material contained in the early records with which we are dealing.

The next records are contained in the letter of Supercargo J. Van Roosenbergh, to the directors of the Dutch East India Company, containing the details of the voyage of his ship, "Het Wapen van Hoorn" to Java.

He says: "On the 17th of September (1627) we sighted the land of d'Eendracht, near Dirck Hartochs reede (Sharks Bay). . . . The many-coloured birds which we met near the islands of Tristan de Aconcha left us two days before, just as they did when we got near the Cape of Good Hope, so that they would seem to dislike the land. Instead of them, we saw a black bird with a white tail, having white streaks here and there under its wings; a bird it seems of rare occurrence. Three or four days before we also saw a number of sandpipers. Close inshore we also saw a quantity of cuttlebone, but the pieces were very small and scattered."

The next references to Western Australian animals are contained in the journals of Francis Pelsart, whose ship, the "Batavia," struck on Houtman's Abrolhos on June 4th, 1629. The crew and passengers having been landed on the islands, Pelsart left them in the ship's boat to look for water. Having examined the islands in vain, he crossed over to the mainland but the precipitous nature of the coast prevented their landing for some days. On the 14th, in latitude 24° S., a little north of Sharks Bay, six of the men swam ashore, but were again unsuccessful in the quest, though they saw some aborigines. The following day they landed again and found some good water in rock holes. "It was evident that some savages had been there a short time before, as they found the remains of crabs and some ashes."

On the morning of the 16th they landed again. "The country was flat without vegetation or trees, with nothing in view but ant-hills, and these so high that they looked afar off like the huts of negroes, and at the same time they were so plagued with flies, and those in such multitudes that they were scarce able to defend themselves. . . . At length, finding that there was no hope of obtaining water, they determined to leave the coast and resolved to make the best of their way to Batavia, to inform the governor of their misfortune, and to solicit assistance for the people they had left in the islands."

In this they were successful, and returned to the Abrolhos, only to find that in their absence the villainous Cornelis and his associates had murdered over 100 of their fellow castaways, with the hope of seizing the relief ship and becoming pirates. Being frustrated in this design, they were captured and executed, with the exception of two of their number, who were landed on the mainland and abandoned there. These two unfortunate convicts were thus the first white inhabitants of Western Australia.

From Pelsart's description of Houtman's Abrolhos we obtain the following zoological information : "The sea abounds in fish in these parts ; they are mainly of three kinds, but very different in shape and taste from those caught on other coasts. All the islands about here are low-lying atolls or coral islets and rocks, except two or three large islands (the Wallaby Islands). . . . . We found in these islands large numbers of a species of cats, which are very strange creatures ; they are about the size of a hare, their head resembling the head of a civet cat ; the forepaws are very short, about the length of a finger, on which the animal has five small nails or fingers, resembling those of a monkey's forepaw. Its two hind-legs, on the contrary, are upwards of half an ell in length, and it walks on these only, on the flat of the heavy part of the leg, so that it does not run fast. Its tail is very long, like that of a long-tailed monkey ; if it eats, it sits on its hind-legs, and clutches its food with its forepaws, just like a squirrel or monkey. Their manner of generation or procreation is exceedingly strange and highly worth observing. Below the belly the female carries a pouch, into which you may put your hand; inside this pouch are her nipples, and we have found that the young ones grow up in this pouch with the nipples in their mouths. We have seen some young ones lying there which were only the size of a bean, though at the same time perfectly proportioned, so that it seems certain that they grow there out of the nipples of the mammæ, from which they draw their food, until they are grown up and are able to walk. Still they keep creeping into the pouch even when they have become very large, and the dam runs off with them when they are hunted. [This account refers to the Dama wallaby, *Macropus eugenii*, which is still plentiful on the islands.[1] In these two islands we also found a number of grey turtle-doves [the brush bronzewing pigeon, *Cosmopelia elegans*, plentiful in the Wallaby Group], but no other animals."

From the journal of Commander Wollebrand Geleynszoon de Jongh we learn that on May 25, 1635, "we sighted the South-land from the ship 'Amsterdam.' We took the latitude, which we found to be 25° 16′ South (about Dirk Hartog Island), but of this we are not quite sure. . . . We saw a good deal of rock-weed floating past our ship, and also a small saturn-gull, and not above 6 or 7 other gulls."

The next discoveries to which I must refer were again the result of a shipwreck. The ship "De Vergulde Draeck" was wrecked on a reef on the coast of the southland in latitude 30° (a little south of Jurien Bay), on the 28th of April, 1656. The Dutch governors of Batavia and the Cape sent several ships to rescue the survivors, but none were found. One of these ships, the "Waeckende Boey," having sent a boat ashore containing fourteen men, as they did not return within twenty-four hours, abandoned them on the supposition that the boat must have been dashed against the rocks and all hands perished. Four of the crew afterwards reached Japara, in Java, the rest having perished on the journey there. They reported that, finding themselves abandoned by the ship, "they repaired their boat, as best they might, with sealskins and provided themselves with a little water and seals' flesh." From the journal of Abraham Leeman, one of the survivors, we learn that "they were obliged to keep themselves alive by eating seals' flesh, gulls, etc."

Samuel Volckersen, skipper of the "Waeckende Boey," published "a brief account of the west-coast of the South-land" in 1658. In this we read that "in slightly under 32° S. Lat. there is a large island, at about 3 (Dutch, 12 English) miles' distance from the mainland of the Southland (Rottnest); here certain animals are found, since we saw many excrements, and besides two seals and a wild cat, resembling a civet-cat, but with browner hair the short-tailed wallaby, *Macropus brachyurus*, the only mammal known on Rottnest]."

The crew of another of the ships searching for the survivors of the "Vergulde Draeck," named the "Emeloort," "on the 15th of March, 1658, saw many gulls, entirely black but of small size probably wedge-tailed petrels (mutton-birds), *Thyellodroma pacifica*], and on the 17th several wag-tails."

We next come to the first visit of Dampier to our shores. Most of the account he gives of his observations I have left in his own words, only condensing his narrative in the passages which do not refer to natural history.

The buccaneering ship "Cygnet," on which was William Dampier, determined in 1686 to sail from America homeward by way of the East Indies. Having successfully crossed the Pacific and cruised for some time in Philippine and Chinese waters, on "the 4th day of January, 1688," says Dampier, "we fell in with the Land of New Holland in the Lat. of 16° 50′ in what is now the Kimberley district . Coasting along to the eastward we found a pretty deep Bay (Cygnet Bay), with abundance of Islands in it, and a very good place to anchor in or to hale ashore," and anchored there next day two miles from the shore, in 29 fathoms. "The Land is of a dry sandy Soil, destitute of Water, except you make Wells; yet producing divers sorts of Trees; but the Woods are not thick, nor the Trees very big. Most of the Trees that we saw are Dragon-trees, as we supposed. . . . We saw no sort of Animal, nor any Track of Beast but once; and that seemed to be the Tread of a Beast as big as a great Mastiff-Dog. Here are a few small Land-birds, but none bigger than a Blackbird; and but few Sea-fowls. Neither is the Sea very plentifully stored with Fish, unless you reckon the Manatee and Turtle as such. Of these Creatures there is plenty; but they are extraordinary shy; though the Inhabitants cannot trouble them much, having neither Boats nor Iron."

Then follows the often-quoted description of the natives, the first detailed account of the Australian aborigines to be published. In the course of this description he says: "Their Eye lids are always half closed, to keep the Flies out of their Eyes; they being so troublesome here, that no Fanning will keep them from coming to ones Face, and without the assistance of both Hands to keep them off, they will creep into ones Nostrils, and Mouth too, if the Lips are not shut very close." The only food of the natives "is a small sort of Fish, which they get by making Wares of Stone across little Coves or Branches of the Sea; every Tide bringing in the small Fish, and there leaving them for a Prey to these People. . . . They have no instruments to catch great Fish Nor could we catch any Fish with our Hooks and Lines all the while we lay there. . . . In other Places at Low-water they seek for Cockles, Muscles, and Periwinkles: of these Shell-fish there are fewer still. . . . Our strikers brought home Turtle and Manatee every day, which was our constant Food."

Having cleaned their ship, they sailed for Sumatra on March the 12th.

Eight years later, in 1696, Willem de Vlamingh sighted the coast of the South Land on the 29th of December. He tells us that "Our people observed a remarkable fish here, about two feet long, with a round head and a sort of arms and legs and even something like hands. . . . On the 31st of December I put on shore with our skipper and directing my steps into the interior of the island Rottnest I found several sorts of herbs, the greater part of which were known to me, and some of which resembled in smell those of our own country. There were also a variety of trees. There are very few birds there and no animals, except a kind of rat as big as a common cat, whose dung is found in abundance over all the island. There are also very few seals or fish, except a sort of sardines and grey rock bream."

On the 5th of January they landed on the mainland at what is now Cottesloe Beach and "proceeded eastwards, without finding anything of consequence, besides a species of large trees whence distilled a kind of gum, like gum-lack, and plenty of wild parrots. After an hour's march we came to a large basin of brackish water Freshwater Bay], which we afterwards found was a river." On the following day "they brought me the nut of a certain fruit tree, resembling in form the 'drioens,' having the taste of our large Dutch beans; and those which were younger were like a walnut [no doubt these were the seeds of the Zamia]. I ate five or six of them, but after an interval of about three hours I and five others who had eaten of these fruits began to vomit so violently that we were as dead men; so that it was with the greatest difficulty that I and the crew regained the shore, and thence, in company with the skipper, were put on board the galliot, leaving the rest on shore."

The whole of the crew returned on board next day and reported finding black swans. "They catched four, two of which were brought alive to Batavia."

On the 10th they proceeded to explore the river with three boats. "We saw many swans (our boat knocked over nine or ten), some cormorants, geese, some divers, etc., also a quantity of fish which were frisking on the water. We also heard the song of the nightingale." Having ascended the river six or seven leagues, they returned.

On the 12th they again landed to try and obtain an interview with the natives but without avail. "The men, the birds, the swans, the cormorants, the pelicans, the geese, the cockatoos, the parroquets, etc., all fled at the sight of us. The best of it is that no vermin is found there; but in the daytime one is terribly tormented with the flies."

They coasted northwards, and on the 15th, in latitude 30° 13′, landed in a bay (perhaps Jurien Bay) and proceeded nearly a league and a half inland; "but we saw no men nor fresh water, but several footsteps of men, and steps like those of the dog, and of the cassowary. One of our people said that he had seen a red serpent. Some others said that as soon as we reached the shore, they saw a yellow dog leaping from the wild herbage, and throwing itself into the sea, as if to amuse himself with swimming. What truth there was in these statements, I do not know. At all events I did not see either of these things myself. . . . On the 17th they brought on board from an island a quantity of sea-mews. The latitude 30° 42′. . . . On the 22nd we landed and found, at two hundred paces from the shore, a brackish stream, along which we walked landwards for a quarter of an hour. The middle was rather deep, and the fish pretty plentiful. We should have followed it further, but, the time being too short, we returned, and on the road saw many footprints like those of a dog; but saw no men, nor animals, nor trees, the country here being twice as barren as what we had before seen."

"On the 25th we found a good many oysters."

"On the 30th we entered Dirk Hartog's Reede (Sharks Bay) Here we caught a good quantity of fish and saw a number of turtles. On the 2nd we took three great sharks, one of which had nearly thirteen little ones of the size of a large pike. Our captain brought back with him a large bird's head, and related that he had seen two nests, made of boughs, which were full three fathoms in circumference."

"On the 5th we took five turtles on the island [Dirk Hartog Island].

"On the 6th we saw a great many turtles, and in the corner of a rock a very large nest made like a stork's nest. On the 7th in the evening we took a fish of immense size, of which twenty-four of us partook. It had exactly the natural taste of the ray. There remained enough for thirty more persons to feed on.

"On the 9th, near the mainland, we saw several ducks."

This account concludes the Dutch contributions to Western Australian natural history. Meanwhile Dampier, on his return to England, had attained to considerable fame by the publication of his travels, and he urged the authorities to allow him to undertake an expedition for the proper exploration of Australia, holding out the hope that gold might be discovered there.

He was put in command of H.M.S. *Roebuck*, an ancient and almost rotten ship, and left England in January, 1698-9. Having called at the Canary and Cape Verde Islands, and in Brazil, they sailed for New Holland.

I quote fully all the portions of his journal which relate to the animals he saw on our coast.

"As we drew nigher the Coast of New Holland, we saw frequently 3 or 4 Whales together. When we were about 90 Leagues from the Land we began to sea Sea-weeds, all of one Sort; and as we drew nigher the Shore we saw them more frequently. At about 30 Leagues distance we began to see some Scuttle-bones floating on the Water; and drawing still nigher the Land we saw greater Quantities of them.

"July 25 (1699) being in Lat. 26 deg. 14 min. S. and Longitude E. from the C. of Good Hope 85 deg. 52 min., we saw a large Gar-fish leap 4 times by us, which seemed to be as big as a Porpoise. It was now very fair Weather, and the Sea was full of a sort of very small Grass or Moss, which as it floated in the Water seem'd to have been some spawn of Fish; and there was among it some small Fry. The next Day the Sea was full of small round Things like Pearl, some as big as white Peas; they were very clear and transparent, and upon crushing any of them a Drop of Water would come forth: The Skin that contained the Water was so thin that it was but just discernable. Some Weeds swam by us, so that we did not doubt but we should quickly see Land. On the 27th also, some Weeds swam by us, and the Birds that had flown along with us all the way almost from Brazil, now left us, except only 2 or 3 Shear-waters. On the 28th we saw many Weeds swim by us, and some Whales, blowing. On the 29th we saw . . . a Scuttle-bone swim by us, and some of our young Men a Seal, as it should seem by their Description of its Head. I saw also some Boneta's, and some Skipjacks, a Fish about 8 Inches long, broad and sizeable, not much unlike a Roach; which our Seamen call so from their leaping about.

"The 30th of July, being still nearer the Land, we saw Abundance of Scuttle-bones and Sea-weed, more Tokens that we were not far from it; and saw also a Sort of Fowls, the like of which we had not seen in the whole Voyage, all the other Fowls having now left us. These were as big as Lapwings; of a grey colour, black about their eyes, with red sharp Bills, long Wings, their Tails long and forked like Swallows; and they flew flapping their Wings like Lapwings. The Birds were further Signs of Land." During the night soundings showed that they were approaching the Abrolhos shoals, so they stood to the northward, and on the following day they sighted land. "August the first, as we were standing in we saw several large sea-fowls, like our Gannets on the Coast of England, flying 3 or 4 together; and a sort of white Sea-Mews, but black about the Eyes, and with forked Tails" [probably crested terns).

The 6th of August they entered Sharks Bay, but they could find no water on Dirk Hartog Island, where they landed.

"There were but few Land-Fowls; we saw none but Eagles, of the larger Sorts of Birds; but 5 or 6 Sorts of small Birds. The biggest Sort of these were not bigger than Larks; some no bigger than Wrens, all singing with great Variety of fine shrill Notes; and we saw some of their Nests with young Ones in them. The Water-Fowls are Ducks (which had young Ones now, this being the Beginning of the Spring in these Parts), Curlews, Galdens, Crab catchers, Cormorants, Gulls, Pelicans; and some Water-Fowl, such as I have not seen anywhere besides. I have given the Pictures of 4 several Birds on this Coast." Fig. 2. Description: "This very much resembles the Guarauna, described and figured by Piso." It is probably intended for the straw necked ibis, *Carphibus spinicollis*. Fig. 3. Description: "The head and greatest part of ye neck of this bird is red, and therein differs from the Avosetta of Italy." It is an obvious figure of the red necked avocet, *Recurvirostra novae hollandiae*. Fig. 4. – Description: "The Bill and Leggs of this Bird are of a Bright Red." This is quite a good figure of the pied oyster catcher, *Haematopus ostralegus*. Fig. 5. Dscription: "A Noddy of N. Holland, P85 & 99." See description further on in the narrative.

"The Land-Animals that we saw here were only a Sort of Raccoons, different from those of the West Indies, chiefly as to their Legs; for these have very short Fore-Legs, but go jumping upon them as the others do (and like them are very good Meat)." This description, often claimed as the first account of the kangaroo, and by Dampier's editor, Masefield, said "more likely to have been the kangaroo-rat," is obviously that of the banded hare-wallaby, *Lagostrophus fasciatus*, as was pointed out by Peron, who named it and gave such a delightful description of its habits. The bands on the fur would naturally recall the raccoon, with which Dampier was familiar from his long residence in the Spanish Main. "And a sort of Guano's, of the same Shape and Size with other Guano's, but differing from them in 3 remarkable Particulars: For these had a larger and uglier Head, and had no Tail: And at the Rump, instead of the Tail there, they had a Stump of a Tail, which appeared like another Head; but not really such, being without Mouth or Eyes: Yet this Creature seem'd by this Means to have a Head at each End; and, which may be reckon'd a fourth Difference, the Legs also seem'd all 4 of them to be Fore legs, being all alike in Shape and Length, and seeming by the Joints and Bending to be made as if they were to go indifferently either Head or Tail foremost. They were speckled black and yellow like Toads, and had Scales or Knobs on their Backs like those of Crocodiles, plated on to the Skin, or stuck into it, as part of the Skin. They are very slow in Motion; and when a Man comes nigh them they will stand still and hiss, not endeavouring to get away. Their Livers are also spotted black and yellow: And the Body when opened hath a very unsavoury Smell. I did never see such ugly Creatures any where but here. The Guano's I have observ'd to be very good Meat: And I have often eaten of them with Pleasure; but tho' I have eaten of Snakes, Crocodiles and Allegators, and many Creatures that look frightfully enough, and there are but few I should have been afraid to eat of, if prest by Hunger, yet I think my Stomach would scarce have serv'd to venture upon these N. Holland Guano's, both the Looks and Smell of them being so offensive." This long and curious account evidently refers to the shingle-back or stump-tailed lizard, *Trachysaurus rugosus*.[1]

"The Sea-fish that we saw here (for here was no River, Land or Pond of fresh Water to be seen) are chiefly Sharks. There are abundance of them in this particular Sound, that I therefore give it the Name of Shark's Bay. Here are also Skates, Thornbacks, and other Fish of the Ray-kind; (one Sort especially like the Sea-Devil) and Gar-fish, Boneta's, etc. Of Shell-fish we got here Muscles, Periwinkles, Limpits, Oysters, both of the Pearl-kind and also Eating-Oysters, as well the common Sort as long Oysters; besides Cockles, etc. The Shore was lined thick with many other sorts of very strange and beautiful shells, for variety of Colour and Shape, most finely spotted with Red, Black, or Yellow, etc., such as I have not seen any where but at this place. I brought away a great many of them; but lost all, except a very few, and those not of the best.

"There are also some green Turtle weighing about 200 lb Of these we caught 2 which the Water Ebbing had left behind a Ledge of Rock, which they could not creep over. These served all my Company 2 Days; and they were indifferent sweet Meat. Of the Sharks we caught a great many, which our Men eat very savourily. Among them we caught one which was 11 Foot long. The space between its two Eyes was 20 Inches, and 18 Inches from one Corner of his Mouth to the other. Its Maw was like a Leather Sack, very thick, and so tough that a sharp Knife could scarce cut it: In which we found the Head and Boans of a Hippopotamus; the hairy Lips of which were still sound and not putrified, and the Jaw was also firm, out of which we pluckt a great many Teeth, 2 of them 8 Inches long, and as big as a Man's Thumb, small at one end, and a little crooked; the rest not above half so long. The Maw was fully of Jelly, which stank extreamly: However I saved for a while the Teeth and the Shark's Jaw: The Flesh of it was divided among my Men; and they took care that no waste should be made of it." The head found in the Shark's maw was probably that of a dugong, as was pointed out by Peron, who discusses this passage. The upper lip of the dugong is "thick and bristly," so would agree with the description. As we have seen, however, Dampier had lived largely on dugongs when on the coast previously, so that he ought to have recognised the animal.

Finding no water, they left Sharks Bay, but "the day before we came out I sent a Boat ashore to the most Northerly of the Two Islands, which is the least of them, catching many small Fish in the mean while with Hook and Line. . . . They saw a large Turtle, and many Skates and Thornbacks, but caught none. . . . In passing out we saw three Water-Serpents swimming about in the Sea, of a yellow Colour, spotted with dark, brown Spots. They were about four Foot long, and about the bigness of a Man's Wrist, and were the first I saw on this Coast, which abounds with several sorts of them."

The *Roebuck* proceeded northwards and on the 16th lost sight of land, "and saw small Dolphins and Whales, and abundance of Scuttle-shells swimming on the Sea; and some Water-snakes every day."

During the night of the 18th "When we were off the Shoal-point I mention'd, where we had but 20 Fathom-water, we had in the Night Abundance of Whales about the Ship, some a-head, others a-stern, and some on each side blowing and making a very dismal Noise; but when we came out again into deeper Water they left us. Indeed the Noise that they made by blowing and dashing of the Sea with their Tails, making it all of a Breach and Foam, was very dreadful to us, like the Breach of the Waves in very Shoal-water, or among Rocks. The Shoal these Whales were upon had Depth of Water sufficient, no less than 20 Fathom, as I said; and it lies in Lat. 22 deg. 22 min."

The 21st day "as we saw some Sea-snakes every Day, so this Day we saw a great many, of two different Sorts or Shapes. One Sort was yellow and about the Bigness of a Man's Wrist, about 4 Foot long, having a flat Tail about 4 Fingers broad. [Probably *Hydrus platurus*]. The other Sort was much smaller and shorter, round and spotted black and yellow." Perhaps *Platurus laticaudatus*. On the evening of the same day they anchored inside Rosemary Island, one of the Dampier Archipelago, on which they landed. "We saw here some Cormorants, Gulls, Crabcatchers, etc., a few small Land-Birds, and a Sort of white Parrots, which flew a great many together. We found some Shell-fish, viz., Limpits, Perriwinkles, and Abundance of small Oysters growing on the Rocks, which were very sweet. In the Sea we saw some green Turtle, a pretty many Sharks, and Abundance of Water-Snakes of several Sorts and Sizes.

"In the Night (of the 23rd) while Calm, we fish'd with Hook and Line, and caught good Store of Fish, viz., Snappers, Breams, Old-Wives and Dog-fish. When these last came we seldom caught any others; for if they did not drive away the other Fish, yet they would be sure to keep them from taking our Hooks for they would first have them themselves, biting very greedily. We caught also a Monk-fish, of which I brought Home the Picture." [The figure is very poor, it probably represents the fish still known by the same name, *Rhina squatina*.]

"The 28th Day we . . . saw no Land . . ., but saw a great many Snakes and some Whales. We saw also some Boobies, and Noddy-birds; and in the Night caught one of these last. It was of another Shape and Colour than any I had seen before. It had a small long Bill, as all of them have, flat Feet like Ducks Feet; its Tail forked like a Swallow, but longer and broader, and the Fork deeper than that of the Swallow, with very long Wings; the Top or Crown of the Head of this Noddy was Coal-black, having also small black Streaks round about and close to the Eyes; and round these Streaks on each Side a pretty broad white Circle. The Breast, Belly, and under part of the Wings of this Noddy were white; and the Back and upper part of its Wings of a faint black or smoke Colour. See a Picture of this, Fig. 5. [This agrees very closely with the Australian brown-winged tern, *Melanosterna anaetheta*, but it might refer to the Australian sooty tern.] Noddies are seen in most Places between the Tropicks, as well in the East-Indies, and on the Coast of Brazil, as in the West-Indies. They rest ashore a Nights, and therefore we never see them far at Sea, not above 20 or 30 Leagues, unless driven off in a Storm. When they come about a Ship they commonly perch in the Night, and will sit still till they are taken by the Seamen. They build on Cliffs against the Sea, or Rocks."

On the 31st August they landed again to search for water, and had an encounter with the natives. "There were several things like Hay-cocks, standing in the Savannah; which at a distance we thought were Houses, looking just like the Hottentot's houses at the Cape of G. Hope; but we found them to be so many Rocks." [Probably, as suggested by Flinders, these were nests of termites.]

The savages here "were much the same blinking Creatures" as he had met with previously, "(here being also abundance of the same kind of Flesh-flies teizing them.) . . . While we were about the Well we were sadly pester'd with the Flies."

"Here are a great many Rocks in the large Savannah we were in, which are 5 or 6 Foot high, and round at top like a Hay-cock, very remarkable; some red, and some white." [Nests of termites.] "There are but few Land-Animals. I saw some

Lizards; and my Men saw two or three Beasts like hungry Wolves, lean like so many Skeletons, being nothing but Skin and Bones: 'Tis probable that it was the Foot of one of those Beasts that I mention'd as seen by us in N. Holland. We saw a Rackoon or two [wallabies ?], and one small speckled Snake.

"The Land-fowls that we saw here were Crows (just such as ours in England), small Hawks, and Kites; a few of each sort: But here are plenty of small Turtle-Doves, that are plump, fat and very good Meat. Here are two or three sorts of smaller Birds, some as big as Larks, some less; but not many of either sort. The Sea-Fowl are Pelicans, Boobies, Noddies, Curlews, See-pies, etc., and but few of these neither.

"The Sea is plentifully stock'd with the largest Whales that I ever saw; but not to compare with the vast ones of the Northern Seas. We saw also a great many Green Turtle, but caught none; here being no place to set a Turtle-Net in; here being no Channel for them, and the Tides running so strong. We saw some Sharks and Parracoots; and with Hooks and Lines we caught some Rock-fish and Old-Wives. Of Shell-fish, here were Oysters both of the common kind for Eating, and of the Pearl kind: And also Wilks, Conchs, Muscles, Limpits, Perriwinkles, etc., and I gathered a few strange Shells; chiefly a sort not large, and thick-set all about with Rays or Spikes growing in Rows."

They continued to coast eastwards until the 7th September. "This day we saw two Water-Snakes, different in Shape from such as we had formerly seen. The one was very small, though long; the other long and as big as a Man's Leg, having a red Head; which I never saw any have, before or since."

By this time they were badly in need of fresh water, and found it difficult to approach the land because of the numerous shoals. "On the 8th of September, therefore, shaping our course for Timor, we were in Lat. 15 de. 37 m. We had 26 Fathom; and we saw one Whale. We found them lying most commonly near the Shore, or in Shoal Water." On the 12th they passed a small sandy island in 13 d. 55 m. "We had Abundance of Boobies and Man of War Birds flying about us all the Day; especially when we came near the Island; which had also Abundance of them upon it; though it was but a little Spot of Land, scarce a Mile round."

They reached Timor on September 15th, and later proceeded to New Guinea, where they discovered the straits separating New Guinea from New Britain, which they named and circumnavigated. From this point they returned by way of Ceram, Batavia and the Cape of Good Hope, but at Ascension the ship foundered, apparently from old age. They all got to land and a fortnight later were rescued and reached England safely.

Besides the figures of birds already referred to, Dampier gives figures of several fish taken on the west coast of Australia. Fig. 1, "the Monk Fish," has already been referred to. Fig. 3, "a Fish taken on the Coast of New Holland," is too indefinite for determination. Fig. 6, "a Remora taken sticking to Sharks backs" is readily recognised by the sucker as *Echeneis remora* or *Leptecheneis naucrates*. There is nothing to show whether Dampier obtained the specimen on our coast, but the latter is frequent there and the figure is on the same plate with the other Australian species. Fig. 8, "a Cuttle taken near N. Holland," is a very rough drawing of some species of cuttle-fish or squid. Fig. 5, "a Fish of the Tunny kind taken on ye coast of N. Holland," has the following account attached: "This is a Fish of the Tunny-kind, and agrees well enough with the Figure in Tab. 3 of the Appendix to Mr. Willughby's History of Fishes under the name of Gurabuca; it differs something, in the Fins especially, from Piso's Figure of the Guarapucu." It appears to be too rough a figure for identification. Fig. 4, "a Fish called by the seamen the Old Wife," is thus described: "This resembles the Figure of the *Guaperva maxima caudata* in Willughby's Ichthyol, Tab. 9, 23, and the Guaperva of Piso, but does not answer their Figures in every particular." [It is evidently the fish still called "Old Wife," *Enoplognathus armatus*. It is referred to several times in the narrative, and is still plentiful on our coast.]

This completes all that was known about the zoology of Western Australia for almost a century, no further natural history observations being made until Vancouver arrived in 1791.

I will conclude this section of my paper with a brief systematic list of the animals mentioned in the narratives which we have just perused.

MAMMALS. Aborigines are referred to in almost all the narratives, and they or traces of them were met with whenever any of the early explorers landed on the coast.

The Dingo (*Canis dingo*) was only seen by Dampier's men on his second visit, and some of Vlaming's men may have also seen one. Vlaming and Dampier, on both his visits, saw their footmarks.

The Dama Wallaby was met with and accurately described by Pelsart on the Abrolhos, whilst the Short-tailed Wallaby was met with by Volckersen and Vlaming on Rottnest. Dampier met with the Banded Wallaby on the islands of Sharks Bay and called it a Raccoon. He also mentions a Raccoon, presumably another kind of Wallaby, as being seen on the North-West Coast.

Of marine mammals, Dampier met with the Dugong on both his visits, and saw numerous Whales, large and small, and Dolphins on the second occasion.

Seals were seen on Rottnest by Volckersen and by Vlaming, the abandoned crew of the *Waeckende Boey* managed to kill enough of them on the coast to keep themselves alive.

BIRDS. It is only natural that the greater number of birds recorded by the early visitors to our coasts were sea-birds, but a fair number of land-birds were also noted.

Vlaming recognised the footprints of the Emu, or, as he called it, Cassowary, the name Emu did not come into use till a later period. He also recorded Parrots, Cockatoos and Parrakeets by the Swan River, whilst Dampier saw White Cockatoos in the north. Dampier met with Crows, Turtle-doves, Hawks, Kites, and Eagles; and Vlaming saw the great nests of the Sea-eagle in Sharks Bay. Pelsart met with the Brush Bronze-wing Pigeons on the Abrolhos. Dampier mentions a variety of small land-birds without further particulars except that many of them sang with shrill notes, but it is difficult to guess what bird was thought by Vlaming to sing like a Nightingale.

Of marine and aquatic birds we have records of Gulls, Terns, Geese, Ducks, Shearwaters, Curlews, Oyster-catchers, Cormorants, Sandpipers, Boobies, Noddies, and Man-of-War Birds; whilst we can recognise the species referred to in the descriptions of the Black Swan, Gannet, Crested Tern, Brown-winged Tern, Pelican, Straw-necked Ibis, Red-necked Avocet, Pied Oyster Catcher, and Wedge-tailed Petrel.

REPTILES.—Mention is made of Turtles in several of the narratives, and Dampier specially mentions the Green Turtle, as well as giving descriptions of several species of Sea snakes.

Of land reptiles we are told of Lizards, a red and a speckled Snake, and the Stump-tailed Lizard.

FISH. Sharks were met with in Sharks Bay and elsewhere, and Vlaming shows that one species at least was viviparous; other Elasmobrauchs mentioned by Dampier are Skates, Thornbacks, Rays, Dog-fish, and the Monk-fish.

Of Teleosteans: Sardines, Grey Rock Bream, Garfish, Bonitos, Skipjack, Snappers, Breams, Old-wives, Barracoutas, a kind of Tunny, and the Remora are recorded.

CRUSTACEA.—The only Crustaceans noted are the Crabs, remains of which Pelsart's men found round a native fire.

INSECTS. Ant-hills, presumably made by Termites, were seen on various parts of the coast, and several explorers note the great prevalence of swarms of Flies.

MOLLUSCS.—Of Molluscs we have mention of Cockles, Mussels, Periwinkles, Whelks, Conchs, Limpets, Pearl Oysters, Rock Oysters, and Hammer Oysters. Dampier figures a Squid and frequently mentions the Cuttle bones which he saw floating on the sea.

The list just given appears to me specially remarkable for its accuracy. Pelsart, Vlaming and Dampier must have been extremely competent observers, since there is nothing in their observations to which we can take exception in view of later knowledge, with the possible exception of a bird with a song like a nightingale, and the hippopotamus' head, which must have been that of a dugong.

Travellers' tales are proverbial, and if any of the explorers had drawn on their imaginations they might easily have peopled the unknown South Land with strange or fabulous animals. We can only conclude that Australia was exceptionally fortunate in the men who devoted themselves to her exploration. We see, too, that before Captain Cook, with Banks and Solander, made the famous discoveries in the East, with which Australian zoology is generally supposed to have started, a considerable amount of accurate information as to the fauna of Western Australia was in existence.

Note. -I am much indebted to the well-known Dutch naturalist, Mr. F. E. Blaauw, for information as to the probable meanings of the names of birds contained in the old documents which I have quoted. The translations contained in Heere's "Part Borne by the Dutch in the Discovery of Australia" and in Major's "Early Voyages to Australia," are frequently wrong, as is only natural, since neither of these authors were ornithologists. In those cases where the names had been left in Dutch, the English equivalents not being known to the translator, Mr. Blaauw's information has enabled me to translate them for the first time.

THIRD ABSTRACT OF THE REPORTS OF THE GERMAN EXPEDITION OF 1905 TO SOUTH-WESTERN AUSTRALIA. By PROFESSOR W. MICHAELSON.

Communicated by Bernard H. Woodward, C.M.Z.S., Director Western Australian Museum. 22nd April, 1913.

Being a Resumé of "Die Fauna Sudwest-Australiens,"
Vol. II., *Parts* 1 *to* 25, 1908-1910, *and* Vol. III., *Parts* 1 *to* 13, 1910-11, *Jena G. Fischer.*
The scientific results of the "Hamburger Sudwest-australische Forschungsreise, 1905."
and edited by Drs. W. Michaelsen and R. Hartmeyer.

Read September 9th, 1913

VOLUME II, Part 1.—CHRYSOMELIDAE and COCCINELLIDAE.

BY J. WEISE (BERLIN).

Pp. 1-13.

These two families of beetles were represented by 21 and 7 species respectively. Of the 21 species of *Chrysomelidae*, 8 were new, of the 7 species of *Coccinellidae* only 1 was new to science.

CHRYSOMELIDAE.

Loxopleurus obtusus, Chap.—East Fremantle.
Ditropidus straminipennis, n. sp., with the *ab. obscurifrons*, Denham.
  ,, *epistomalis*, n. sp.—Dirk Hartog.
  ,, *michaelseni*, n. sp.—Dirk Hartog.
Geloptera tuberculata, Baly.—Harvey, Boyanup.
Rhembastichus, n. gen. *variabilis*, n. sp.—Yalgoo.
Colaspoides picipes, n. sp.—Brunswick.
  ,, *geminata*, n. sp.—Boyanup.
Trochalodes hemisphaerica, Chap.—Dirk Hartog.
Trachymela hartmeyeri, n. sp.—Boyanup.
  ,, *punctata*, Marsh.—Boorabbin.
Pyrgo apicata, Clark.—Northampton.
  ,, *niobe*, Blackb. (with many variations in the colouration of the elytra).—Dirk Hartog.
  ,, *substriata*, Chap. (with ab. *bipunctata*, Denham).—Dirk Hartog.
  ,, *suturalis*, Germ. var. nov. *clara*.—Dirk Hartog.
  ,, *obtusata*, Ws.—Geraldton.
  ,, *mediovittata*, Clark, ab. *scaphoides*, Blackb.—Cranbrook.
Calomela maculicollis, Boids.—Albany.
Chalcolampra simillima, Baly. Yalgoo, Coolgardie.
  ,, *nana*, n. sp.—Denham.
Psylliodes 4-dentata, Baly.—Denham, Dongarra.

COCCINELLIDAE.

Coccinella repanda, Thunb. *ab. contempta*, Boisd.—Kalgoorlie.
Chilomenes 6-maculata, var. nov. *australis.*—Subiaco, North Fremantle.
Diomus scapularis, Ws.—Yalgoo.
,, *labiatus*, n. sp.—Denham.
Rhizobius occidentalis, Blackb. (?)—Monger's Lake, nr. Subiaco.
,, *submetallicus*, Crotch.—Day Dawn.
,, *lophanthae*, Blaesdell.—Subiaco.

VOLUME II, Part 2. STAPHYLINIDAE.

By Dr. Max Bernhauer (Grunberg, O.O.).

Pp. 15-23.

The author described some species from other parts of Australia amongst the Western Australian species. These species are omitted.

Oxytelus scabrellus, Fauv.—Dongarra.
,, *impennis*, Fauv. var.—Dongarra.
,, *cribriceps*, Fauv.—Serpentine, Donnybrook, Torbay.
,, *antipodum*, n. sp.—Dongarra, Serpentine.
Paederus erichsoni, n. sp. MacGuire, Eradu, Moora, Wooroloo, Mundaring Weir, Pinjarra, Collie, Bunbury, Gooseberry Hill, Cranbrook.
Asenus australicus, n. sp.—Wooroloo
Lathrobium (subgen. *Nothobium*) *michaelseni*, n. sp.—Brunswick, Gooseberry Hill, York.
Xantholinus socius, Fauv.—East Fremantle.
Philonthus longicornis, Steph.—Harvey.
Creophilus erythrocephalus, F. Fremantle, Mundijong.
Quedius diverspinnis, Fauv. -Wooroloo, Lion Mill, Donnybrook.
Atheta gentilis, Fauv.—Serpentine.
,, *politula*, Fauv. (?).—Dongarra.

VOLUME II, Part 3.—TRICHOPTERA and EPHEMERIDAE.

By Georg Ulmer (Hamburg).

Pp. 25-46, with 44 figures in the text.

All the *Trichoptera* of the examined collection, with the exception of one species, are new to science, and, with the same exception, differ from those known from the Eastern States of Australia. Certain genera prove to have a much wider distribution than had previously been supposed. *Triplectides*, formerly only known from New Zealand and Brazil, is represented by two new species in this Australian collection, and *Dolophilus*, formerly only known from Europe, by one species. We must suppose that this latter genus also occurs in the intermediate parts of Asia

The larvae in the collection are determined only as far as to the genus or even not so far.

The *Ephemeridae* in the collection do not represent many new species, but the material is of interest, as it enables the author to give complete descriptions of some incompletely known species.

The list and the descriptions of the Western Australian species are preceded by a list of all species known from Australia, but, in this report, only the one species of *Trichoptera* previously known from Western Australia, *Plectrotarsus gravenhorsti*, Kolenati, need be mentioned.

TRICHOPTERA.

Family LEPTOCERIDAE.

Triplectides delicatula, n. sp. -Lion Mill, Serpentine, Brunswick.
,, *flava*, n. sp.—Wooroloo, Serpentine.
Notanatolica magna, Walker. -Monger's Lake, near Subiaco.
Larvae :—*Triplectides* (?) sp.—Yalgoo.
gen. (?) sp. (?).—Serpentine River.
gen. (?) sp. (?).—Brunswick.
Oecetis sp.—Yalgoo.

Family HYDROPSYCHIDAE.

Smicridea australis, n. sp.—Jarrahdale.

Family PHILOPOTAMIDAE.

Dolophilus michaelseni, n. sp. (Imago and Larva). -Brunswick.

Family HYDROPTILIDAE.

Larva :—*Hydroptila* (?) sp.—Lion Mill.

EPHEMERIDAE.

Atalophlebia furcifera, Eaton.—Serpentine.
,, *inconspicua*, Eaton.—Lion Mill, Brunswick.
Baetis soror, n. sp.—Serpentine.
Nymphae :—*Atalophlebia* sp. Lion Mill, Serpentine, Brunswick.
,, sp.—Jarrahdale, Serpentine.

VOLUME II, Part 4. –THYSANURA.

By F. Silvestri (Portici).

Pp. 47-68, with Plates I-X.

The collection contains 16 species, of which 12 are new. This great number of new species is due to the fact that not one species was previously known from South-Western Australia, and that from the whole continent only two species (*Acrotelsa producta*, Esch., and *Machilis froggatti*, Silv.) were known.

Family LEPISMATIDAE.

Lepisma saccharina, L.—Denham (?).
Heterolepisma stilivarians, n. sp.—Northampton, Yalgoo, Mount Robinson (near Kalgoorlie), Coolgardie, Boorabbin, Wooroloo, Karrakatta, East Fremantle, Donnybrook, Boyanup.
,, *michaelseni*, n. sp.—Torbay, Lion Mill, Boyanup.
,, *kraepelini*, n. sp.—Yalgoo.
,, *hartmeyeri*, n. sp.—Northampton.
Ctenolepisma longicaudata, Esch. Denham, Fremantle, Rottnest.
Thermobia domestica, Pack.—Day Dawn.
Acrotelsa producta, Esch.—Eradu.
,, *devriesiana*, n. sp.—Dirk Hartog, Geraldton, Yalgoo Moonyoonooka, Dongarra, Kalgoorlie, East Fremantle, Fremantle, Yarloop, York.
,, ,, n. subsp. *perspinata*.—Denham, Dongarra.
Atelura similata, n. sp.—Boorabbin.
,, *disjuncta*, n. sp.—Guildford, Gooseberry Hill
Atopatelura michaelseni, n. sp.—Gooseberry Hill.
,, *kraepelini*, n. sp.—Albany.
,, *hartmeyeri*, n. sp.—Gooseberry Hill.
Trinemura n. gen. *novae-hollandiae*, n. sp. –Gooseberry Hill.

Family JAPYGIDAE.

Japyx longiseta, n. sp.—Lion Mill, Lunenberg.

VOLUME II, Part 5.—DERMAPTERA.

By Malcolm Burr (Eastry, Kent).

Pp. 69-80, with Plate XI.

"Our knowledge of the earwigs of the Australian Region is very meagre. Scarcely thirty species have been recorded from the mainland, even including Tasmania and New Zealand." Only three species were known from Western Australia, and these three species are represented in the Hamburg collection.

Labidura truncata, Kirby. -Tamala, Geraldton, Coolgardie, Mundaring Weir, Fremantle (previously known from W.A.).
Anisolabis sp. incert.—Mundaring Weir.
,, *brunneri*, Dohrn. Upper Blackwood District, Bridgetown, Boyanup, Albany (formerly recorded from Albany).
,, *occidentalis*, Kirby. Guildford, North Fremantle, East Fremantle, Fremantle, Rottnest, Bunbury, Busselton (previously recorded from Cape Leuwin).
Gonolabis michaelseni, n. sp.—Geraldton, Eradu, Fremantle, Collie.

Gonolabis woodwardi, n. sp. Denham, Dirk Hartog, Geraldton, Dongarra, Eradu, Coolgardie, Boorabbin, Wooroloo, Lion Mill, Mundaring Weir, Guildford, South Perth, Subiaco, North Fremantle, Fremantle, Cannington, Harvey, Brunswick, Donnybrook, Gooseberry Hill, Broome Hill, Albany.
n. var. *dentata.*—Collie, Bunbury, Bridgetown.
,, n. var. *forcipata.*—Northampton.

VOLUME II, Part 6.—ROTATORIA, TARDIGRADA and other animals living in moss.

BY PROF. FERDINAND RICHTERS (FRANKFURT A.M.).

Pp. 81-85, with three figures in the text.

The animals recorded in this part were detected in dry cushions of moss and lichen sent to the author, and wetted by him in order to cause the dry microscopical animals to swell, and thus to regain their original form.

The materials consisted of :—

1. A clod of a fruit-bearing *Grimmia* from a bare granite hill near Boorabbin ;
2. A clod of *Platygyrium* accompanied by a shrub-like lichen from Bridgetown ; and
3. Some lichen crusts taken from a bare granite rock at Kalgoorlie.

PROTOZOA.

Amoeba terricola, Greeff.—Boorabbin
Amphizonella (?) sp.—Boorabbin.
Difflugia globulosa, Duj.—Boorabbin, Kalgoorlie.
,, *constricta*, Ehrbg.—Bridgetown.
Euglypha semilunum, Ehrbg. Boorabbin, Bridgetown.
,, *ciliata*, Ehrbg.

ROTATORIA.

Callidina (?) sp. (5 different species).—Boorabbin, Kalgoorlie, Bridgetown.
Callidina sp.—Kalgoorlie.

NEMATODES.

Three different species of *Dorylaimus* to be examined and described later on by Dr. Bresslau.

COPEPODA.

Canthocamptus sp.—Boorabbin.
Epactophanes (?) sp.—Boorabbin.

TARDIGRADA.

Macrobiotus hufelandi, C. Sch. -Boorabbin, Kalgoorlie, Bridgetown.
,, ,, var. *simplex.*—Boorabbin.

ACARINA.

Oribata sp., the larva of another species of *Oribatidae*, and part of a species of *Gamasidae*.

MYRIAPODA.

Polyxenus lagurus, L.—Bridgetown.

INSECTA.

Larva of *Sciara* sp.

In an appendix to this part is recorded the occurrence of a species of *Rotatoria*, viz., *Asplanchna brightwelli*, Gosse, determined by R. Volk (Hamburg), from Monger's Lake, near Subiaco.

VOLUME II, Part 7.—SCORPIONES.

BY PROF. K. KRAEPELIN (HAMBURG).

Pp. 87-104, with part of Plate XII (Fig. 1-11).

Very few scorpions occur in Australia, of the six families only the *Buthidae*, *Scorpionidae* and *Bothriuridae* being present. The collection contains eight species, of which four are new.

Lychas marmoreus, C. L. Koch. --Northern typical race : Northampton, Eradu. Southern race : Boorabbin, Lion Mill, Subiaco, Brunswick, Boyanup. Doubtful : Moora.
Urodacus planimanus, Poc. –Jarrahdale (previously recorded from Perth).
,, *novae-hollandiae*, Pet.—Wooroloo, Lion Mill, Subiaco, Jarrahdale, Serpentine, Gooseberry Hill, Pickering Brook, York.
,, *woodwardi*, Poc.—Murchison District (?).
,, *hartmeyeri*, n. sp.—Tamala.
Cercophonius michaelseni, n. sp.—Boorabbin.
,, *granulosus*, n. sp.—Geraldton, Moonyoonooka.
,, *sulcatus*, n. sp.—Collie, Lunenberg, Boyanup, Torbay, South Albany.

VOLUME II, Part 8. SCOLOPENDRIDAE.

BY PROF. K. KRAEPELIN (HAMBURG).

Pp. 105-128, with part of Plate XII (Fig. 12-17).

The Western Australian fauna of *Scolopendridae* was previously almost entirely unknown. The collection confirms the presumption that the general character of the W.A. fauna corresponds to that of the other Australian regions, and that certain genera of the Oriental region have scarcely, if at all, penetrated to the South-Western part of the continent. The two chief genera of the oriental family *Otostigminae* are not represented in the collection, which is rich at least in individuals. Of the thirteen species nearly half are new, but without much modifying the general character of the Australian fauna. The two newly discovered genera, *Colobopleurus* and *Hemicormocephalus*, which were previously regarded as typically South African, are, however, of considerable interest.

Cryptops haasei, Att.—York, Serpentine, Harvey, Donnybrook.
,, *australis*, Newp.—Lion Mill, Mundaring Weir, Guildford, Cannington, Pickering Brook, Jarrahdale, Harvey, Bunbury, Boyanup, Donnybrook, Bridgetown, Albany.

Ethmostigmus rubripes, Brdt.—Boorabbin, Wooroloo, Subiaco, Dongarra, Baba Head and Tamala in Edelland, Dirk Hartog, Denham.

Colobopleurus inopinatus, n. sp.—Karrakatta.

Cormocephalus michaelseni, n. sp.—Collie, Bridgetown, Albany.
,, *turneri*, Poc.—Yalgoo, Northampton, Kalgoorlie, Tamala in Edelland, Boorabbin, York, Wooroloo, Mundaring Weir, Pickering Brook, Fremantle.
,, ,, var. n. *yalgooensis*.—Yalgoo.
,, *aurantiipes*, Newp.—Geraldton, York, Beverley, Cranbrook, Albany.
,, *distinguendus*, Haase.—Tamala in Edelland, Geraldton, Dongarra.
,, *hartmeyeri*, n. sp.—Guildford, Jarrahdale, Pinjarra, Harvey, Collie, Bunbury, Bridgetown, Donnybrook, Boyanup, Broome Hill, Cranbrook, Torbay, Albany.
,, *strigosus*, n. sp.—Northampton, Day Dawn, Yalgoo, Arrino, Moora, Wooroloo, Lion Mill, Gooseberry Hill, Pickering Brook, York, Jarrahdale.

Hemicormocephalus novae-hollandiae, n. sp.—Fremantle, Subiaco.

Scolopendra morsitans, L.—Baba Head and Tamala in Edelland, Northampton, Day Dawn, Yalgoo, Eradu, Moora, Kalgoorlie, Coolgardie.
,, *laeta*, Haase, var. n. *viridis*.—Wooroloo, Mundaring Weir, Cannington, Yarloop, Harvey, Collie, Brunswick, Bunbury, Bridgetown, Boyanup, Gooseberry Hill, York.
,, ,, var. n. *fasciata*.—Denham, Tamala in Edelland.
,, ,, var. n. *flavipes*.—Yalgoo.
,, ,, var. n. *flavipes*, ab.—Day Dawn.

VOLUME II, Part 9. -BLATTIDAE.

By R. Shelford M.A., F.L.S. (Oxford).

Pp. 129-142, with Plate XIII.

"The collection illustrates admirably the fact that Australia is the head-quarters of the apterous cockroaches belonging to the *Polyzosteria* group of the subfamily *Blattinae*, no fewer than 27 species out of a total of 41 being of this section. Australia presents so many evidences of the great antiquity of its fauna that I should like to be able to assert with confidence that the *Polyzosteriae* constitute a very ancient group of cockroaches, but this I cannot conscientiously do. The geological evidence is directly opposed to the view that apterous *Blattidae* are more primitive than winged forms and the method of depositing the eggs in a chitinous capsule as do all the *Blattinae* cannot be regarded as other than a highly specialised habit; we can only say that it is probably a more primitive habit than is viviparity in this group of Orthoptera. It is quite likely that the climatic conditions of Australia are in part responsible for the large proportion of apterous species of *Blattidae* in that continent; without being able to explain the reason it is nevertheless a fact that in desert regions or in regions where droughts are of long duration apterous species of *Blattidae* are more numerous than winged species, whilst in the moist jungles of West Africa and the Malay Archipelago the converse is true. The collection of Drs. Michaelsen and Hartmeyer illustrates this fact also, for of the eleven species not belonging to the apterous *Polyzosteria* group, only six possess wings capable of flight, and of these 6 species, 2 are importations from extra-Australian areas, and 1 is winged in the male sex only. 11 of the species in the collection I regard as new to science."

Subfamily PHYLLODROMIINAE.

Phyllodromia germanica, L.—Denham, Fremantle.
,, sp.—Guildford.
,, *liturata*, Tepp.—Guildford.
Allacta similis, Sauss.—Torbay.
Ceratinoptera ensifera, n. sp. Jarrahdale, Lunenberg, Bridgetown.
Temnopteryx platysoma, Walk.—North Fremantle, Boyanup, Torbay.
Loboptera circumcincta, Tepp.—Denham, Dirk Hartog, Northampton, Coolgardie, Lion Mill, Guildford, Fremantle, Gooseberry Hill, York.
,, *duodecimsignata*, Tepp. Lion Mill, Subiaco, Karrakatta, Buckland Hill, Fremantle.

Subfamily EPILAMPRINAE.

Epilampra sp.—Denham, Moora, Donnybrook.

Subfamily BLATTINAE.

Polyzosteria cuprea; Sauss.—Albany, South Albany.
,, *pubescens*, Tepp.—Kalgoorlie.
,, *subverrucosa*, White.—Upper Blackwood District.
,, *mitchelli*, Angas.—Fremantle.
,, *ruficeps*, n. sp.—Moora.
,, *invisa*, Walk.—Geraldton, Broome Hill.
,, *atrata*, Er.—Boorabbin.
,, *consobrina*, Sauss.—Fremantle.
,, *armata*, Tepp.—Kalgoorlie, Coolgardie.
,, *curiosa*, n. sp.—Northam.
,, *scabriuscula*, Tepp.—Moora, Wooroloo, Lion Mill, Subiaco, Brunswick, Bridgetown, Donnybrook Pickering Brook, Cranbrook.
,, *obscura*, Tepp.—East Fremantle.
,, *morosa*, n. sp.—Lion Mill, Mundaring Weir, Jarrahdale, Broome Hill, Albany, South Albany.
,, *conjuncta*, n. sp.—Collie.
,, *inclusa*, Walk.—Northampton, Geraldton, Moonyoonooka, Wooroloo, Lion Mill, Guildford, East Fremantle, Serpentine, Collie, Donnybrook, Cranbrook.
,, *variegata*, n .sp.—Boyanup.
,, *albomarginata*, Br.—Coolgardie.
,, *obscuripes* Tepp.—Fremantle, Cranbrook.
,, *semivitta*, Walk.—Guildford, Cottesloe, East Fremantle, Harvey, Boyanup, Pickering Brook.

Platyzosteria hartmeyeri, n. sp.—Boorabbin.

Cutilia heydeniana, Sauss.—Albany.

Zonioploca medilinea, Tepp.—Kalgoorlie.
,, *pallida*, n. sp.—Dongarra, Lion Mill, Rottnest, Collie, Brunswick, Donnybrook, Boyanup, Busselton, Pickering Brook.

Anamesia polyzona, Walk.—Dirk Hartog, Eradu, Fremantle.
,, *frenchii*, Tepp.—Day Dawn, Eradu.

Desmozosteria michaelseni, n. sp.—Boorabbin.
,, *rufescens*, n. sp.—Denham.

Stylopyga michaelseni, n. sp.—Boorabbin.

Periplaneta americana, L.—Denham.

Subfamily OXYHALOINAE.

Ectoneura margarita, Tepp.—Boorabbin.

Subfamily PANCHLORINAE.

Oniscosoma granicollis, Sauss.—Guildford, Subiaco, East Fremantle, Boyanup, Upper Blackwood District, Torbay.

VOLUME II, Part 10.—COPELATA and THALIACEA.

By Prof. H. Lohmann (Kiel).

Pp. 143-149, with 1 figure in the text.

With the exception of one species of *Doliolum*, the pelagic *Tunicata* belong to the class of *Appendicularia*. *Salpae* and *Pyrosomae* were not found. *Appendicularia* were contained in nine hauls of the tow net, six from Sharks Bay and three from the Fremantle region. Most of these hauls showed the influence of the shallow coastal area, *Oikopleura dioica* predominating in them. But three hauls from Sharks Bay were exceptional, as they contained four other species of *Oikopleura* (*O. longicauda*, *O. fusiformis*, *O. rufescens*, and *O. cophocerca*). All these species of *Oikopleura* belong to the warm-water fauna and are generally distributed over all three oceans ; but, whilst the latter species generally occur at a distance from the coast, and do not extend beyond the limits of warm water, *O. dioica* is, on the contrary, abundant on the coasts, and extends far into the region of cooler waters. The three collections with open-water species were caught in the South Passage of Sharks Bay, where at flood-tide a strong current enters from the open sea. The influence of this current may be seen in the relative composition of the different hauls. On approaching the South Passage the number of species increases and, whilst the number of *O. dioica* diminishes, that of the open-water species increases, especially that of *O. longicauda* and *O. fusiformis*. *O. cophocerca* appears only immediately opposite the South Passage. No species characteristic of the "Westwind-drift" were found. Especially remarkable is the absence of *Fritillaria borealis* in the hauls from the Fremantle area.

COPELATA.

Oikopleura cophocerca, Gegenb. Sharks Bay, between Inner Bar and South Passage.

,, *rufescens*, Fol.—Sharks Bay, between Inner Bay and South Passage, and near Dirk Hartog I., off Brown Station.

,, *longicauda*, Vogt.—Sharks Bay, at the same localities.

,, *fusiformis*, Fol. -Sharks Bay, at the same localities.

,, *dioica*, Fol.—Sharks Bay, between Inner Bar and South Passage, and off Denham, Swan River off North Fremantle, Cockburn Sound.

Fritillaria abjornseni, n. sp. Fremantle, Cockburn Sound, Swan River off North Fremantle.

THALIACEA.

Doliolum denticulatum, Q. and G.—Sharks Bay, between Inner Bar and South Passage.

VOLUME II, Part 11.—MARINE HYDRACHNIDAE and HALACARIDAE.

By Prof. H. Lohmann (Kiel).

Pp. 151-154, with 2 figures in the text.

Marine mites were found only at six stations, and only one specimen at each station. Indeed, these animals seem to be very scarce in these coastal districts, for, from a careful search of thirteen residues which appeared especially promising, no more than three specimens resulted.

Of the four species, three belong to the Halacarids and one to the Hydrachnids. Two species were new. The other two species, *Halacarus panopae* and *Agaue hirsuta*, show a wide distribution on the coasts of the warm water areas of the ocean, and have already been recorded from the south-eastern coast of Australia.

Pontarachna denhami, n. sp.—Sparks Bay, off Denham.
Halacarus panopae, Lohm.—Sharks Bay, off Denham ,and N.N.E. from the northern point of Heirisson Prong.
,, *australiensis*, n. sp.—Sharks Bay, N.W. from Middle Bluff, and N.N.E. from the northern point of Heirisson Prong.
Agaue hirsuta, Troness.—Champion Bay, off Geraldton.

VOLUME II, Part 12.—ARANEAE, Part 2.

By Eugene Simon (Paris).

Pp. 155-212, with 14 figures in the text.

In the preface the author gives some statements about the distribution of the different families represented in the collection from Western Australia, as well as some notes about the systematic position of certain genera.

In the main part, the author first notes some species belonging to families and subfamilies already treated in the First Part of the *Araneae* (Vol. I, part 12), and then cotinues the enumeration and description of the species, going on with the family *Clubionidae*, some subfamilies of which were treated in the final portion of the first part.

Family DRASSIDAE (Suppl.).

Subfamily Hemicloeniae.

Trachytrema castaneum, n. sp.—Day Dawn.

Family CLUBIONIDAE.

Subfamily Selenopinae.

Selenops australiensis, L. Koch.—Pickering Brook.

Subfamily MOLYCRIEAE (Suppl.)

Ceryerda cursitans, n. gen., n. sp.—Day Dawn.

Subfamily CLUBIONINAE.

Clubiona robusta, L. Koch.—Dirk Hartog, Kalgoorlie, Coolgardie, Boorabbin, Subiaco, Collie, Boyanup, Torbay, Albany (previously recorded from Swan River).
,, *cycladata*, n. sp.—Guildford, Collie, Torbay.
,, *munis*, n. sp.—Day Dawn.
,, *laudabilis*, n. sp.—Denham.
Chiracanthium nervosum, n. sp.—North Fremantle.
,, *pennuliferum*, n. sp.—Subiaco, Albany.

Besides these species, *Chiracanthium brevicalcaratum*, L. Koch, is recorded from Swan River.

Subfamily CTENINAE.

CALOCTENEAE.

Argoctenus nebulosus, n. sp.—Cranbrook.
,, *hystriculus*, n. sp.—Cannington.
Elassoctenus harpax, n. gen., n. sp.—Geraldton, Wooroloo, Lion Mill.
Hestimodema ambigua, n. gen., n. sp.—Lion Mill, Cannington.
,, *latevittata*, n. sp.—Fremantle, Donnybrook.

ZOREAE.

Ctenomma lineatum, E. Simon.—Wooroloo.

MITURGEAE.

Miturga occidentalis, n. sp.—Tamala in Edelland, Yalgoo, Eradu, Kalgoorlie.
,, *ferina*, n. sp.—Broome Hill.
,, *catograpta*, n. sp.—Geraldton, Lion Mill, Pickering Brook.
,, *whistleri*, n. sp.—Upper Blackwood District, Collie.
,, *impedita*, n. sp.—Pickering Brook.
,, *agelenina*, n. sp.—Buckland Hill near North Fremantle, East Fremantle.

Here follow the descriptions of two species, *M. thorelli*, n. sp. from Cook Town, and *M. severa*, n. sp. from Victoria (in the author's collection).

Diaprograpta striola, n. gen., n. sp.—Boorabbin.

Subfamily MICARIINAE.

Supunna michaelseni, n. sp.—Harvey.
,, *smaragdinea*, n. sp.—Wooroloo.
Liparochrysis resplendens, n. gen., n. sp.—Lunenberg.

Subfamily Corinninae.

Asadipus nitidiceps, n. sp.—East Fremantle, Busselton.

Aristerus phaleratus, n. gen., n. sp.—Day Dawn, Yalgoo, Boorabbin.

Family AGELENIDAE.

Subfamily Nicodaminae.

Nicodamus bicolor, L. Koch.—Murchison District (?), Geraldton, Eradu, Dongarra, Moora, Boorabbin, East Fremantle, Mundijong, Upper Blackwood District, South Albany.

Subfamily Cybaeinae.

Desis hartmeyeri, n. sp.—Albany.

Subfamily Hahninae.

Scotopsilus sp.—Torbay.

Family PISAURIDAE.

Dolomedes facetus, L. Koch.—Pinjarra, Bunbury, Boyanup, Albany.

Family LYCOSIDAE.

Lycosa leuckarti, Thorell.—Wooroloo, Guildford, East Fremantle, Donnybrook, Gooseberry Hill, York, Beverley.

,, *christopheri*, n. sp.—Fremantle.

,, *woodwardi*, n. sp.—Northampton, Dongarra, Beverley.

,, *immansueta*, n. sp.—Wooroloo, Cannington.

,, *dimota*, n. sp.—Day Dawn.

,, *pullastra*, n. sp.—Mundaring Weir, vicinity of Albany.

,, *marcentior*, n. sp.—Dongarra, Boyanup.

,, *segregis*, n. sp.—Fremantle.

,, *propitia*, n. sp.—Cannington.

,, *percauta*, n. sp.—Rottnest.

,, *impedita*, n. sp.—Gooseberry Hill.

,, *oraria*, L. Koch.—Fremantle (previously recorded from King George's Sound.)

,, *sibyllina*, n. sp.—Albany.

,, *properipes*, n. sp.—Guildford, Subiaco.

,, *phegeia*, n. sp.—Cannington.

,, *meracula*, n. sp.—Denham, Albany.

Pardosa praevelox, n. sp.—Buckland Hill, near North Fremantle.

Artoria flavimanus, n. sp.—Mundaring Weir.

,, *cingulipes*, n. sp.—Collie.

,, *taeniifera*, n. sp.—Bunbury.

Family OXYOPIDAE.

Oxyopes sp.—Numerous immature specimens.

Family SALTICIDAE.

SALTICIDAE PLURIDENTATI.

ASTIEAE.

Astia tristicula, n. sp.—Subiaco, Bunbury, Boyanup.
Helpis occidentalis, n. sp.—Guildford, Torbay.
Adoxotoma nigro-olivacea, n. gen.,n . sp.—Collie.
,, *chionopogon*, n .sp.—Wooroloo, Lion Mill.

SALTICIDAE UNIDENTATI.

SAITEAE.

Saitis michaelseni, n. sp.—Boyanup.
,, ,, *obscurior*, n. subsp.—Subiaco, Cannington.
,, *heteropogon*, n. sp.—Busselton.

MARPISSEAE.

Breda jovialis, L. Koch.—Lion Mill (previously recorded from W.A.).
Holoplatys planissima, L. Koch.—Boorabbin.
,, *quinquecingulata*, n. sp.—Day Dawn.
,, *fractivittata*, n. sp.—Moonyoonooka, Midland.
Ocrisiona leucocomis, L. Koch.—Guildford, Jarrahdale, Bunbury.
Muziris carinatus, n. sp.—Wooroloo.
Clynotis viduus, L. Koch.—Cranbrook.
,, *albopictus*, n. sp.—Harvey, Bunbury.

AELURILLEAE.

Habrocestum chrysomelas, n. sp.—Lion Mill.
,, *speculiferum*, n. sp.—North Fremantle.

HYLLEAE.

Eugasmia chlorophthalma, n. sp.—York.

SALTICIDAE FISSIDENTATI.

SERVAEEAE.

Servaea spinibarbis, n. sp.—Subiaco, Cottesloe, Buckland Hill near North Fremantle, North Fremantle, East Fremantle, Fremantle.

TRITEAE.

Opisthoncus devexus, n. sp.—Dirk Hartog.
,, *machaerodus*, n. sp.—Midland.

SIMAETHEAE.

Simaethula chalcops, n. sp.—Subiaco.

A general catalogue of all *Araneae* now known from Western Australia follows. This catalogue records 230 different species (including a small number of subspecies), by far the greater part of which are here recorded for the first time from W.A., among them 160 new species (including a small number of subspecies). Among the new species are the types of 20 new genera.

VOLUME II, Part 13.—PTINIDAE.

By M. Pic (Digoin).

P. 213.

The collection contained only one species of this family of beetles, viz. :—

Paussoptinus brevipennis, n. sp.—Moora.

VOLUME II, Part 14. CURCULIONIDAE.

By Arthur M. Lea (Hobart).

Pp. 215-232.

The collection of this family of beetles is relatively so small that it would be of small use to generalise on these species.

OTIORHYNCHIDES.

Homoeotrachelus australasiae, Fst.—Tamala in Edelland.
,, *hadromerus*, Lea.—Denham, Dirk Hartog.
Titinia brevicollis, Blackb.—Dirk Hartog.
,, *incisicollis*, n. sp.—Denham, Dirk Hartog.

LEPTOPSIDES.

Catasarcus spinipennis, Fhs.—Buckland Hill near North Fremantle. Fremantle.
,, *rufipes*, Fhs.—Subiaco, Cottesloe, Buckland Hill near North Fremantle, Yarloop.
,, *maculatus*, Pasc.—Perth.
Leptops colossus, Pasc.—Tamala in Edel-land.
,, *spinosus*, Fhs.—Torbay.
Cherrus longulus, Blackb.—Kalgoorlie, Coolgardie, Boorabbin.
,, *punctipennis*, Pasc.—Donnybrook.
,, *aureolus*, Pasc.—Lion Mill, Collie.
Polyphrades aesalon, Pasc.—Bunbury, Albany.
,, *pardalotus*, Pasc.—Boyanup.
,, *hartmeyeri*, n. sp.—Dirk Hartog.
,, *uniformis*, n. sp.—Coolgardie, Boorabbin.
Essolithna echimys, Pasc.—Harvey, Lunenberg, Bridgetown, Boyanup.
,, *seriata*, Blackb.—Boorabbin.
,, *villosa*, n. sp.—Eradu.

AMYCTERIDES.

Talaurinus dameli, Macl.—Albany.
Acantholophus rugiceps, Macl.—Torbay.
,, *suturalis*, Boh.—Lion Mill, Subiaco, Collie, Boyanup.
,, *amycteroides*, Macl.—Collie.
,, *crassidens*, Macl.—Yarloop.

Polycreta metrica, Pasc.—Eradu.
Cubicorrhynchus spinicollis, Macl. Gooseberry Hill.
,, *crenicollis*, Wath.—Dirk Hartog, Geraldton, Buckland Hill near North Fremantle.
,, *valgus*, n. sp.—Day Dawn.
,, *bohemani*, Boh.—Northampton, Eradu, Moonyoonooka, Coolgardie.
,, *maximus*, Macl.—Kalgoorlie, Gooseberry Hill.
Euomus basalis, Boi.—Cranbrook.
Dialeptopus sepidioides, Pasc.—Moora.

RHYPAROSOMIDES.

Timareta figurata, Pasc.—Geraldton.

CYLINDRORHINIDES.

Ocynoma antennata, Pasc.—Fremantle.

MOLYTIDES (?).

Aphela helopoides, Pasc.—Cottesloe.

GONIPTERIDES.

Oxyops multidentata, Lea.—Coolgardie.
Bryachus squamicollis, Pasc.—Kalgoorlie.

ATERPIDES.

Hyphaeria curtula, Pasc.—Fremantle.

ERIRHINIDES.

Desiantha praemorsa, Lea.—Fremantle.
,, *maculata*, Blackb.—Fremantle.
Nemestra incerta, Pasc. –Subiaco.
Dicomada litigiosa, Pasc.—Fremantle.
Storeus filirostris, Pasc.—Guildford.
,, *variabilis*, Lea.—Fremantle.
,, *multiarticulatus*, Lea.—Dirk Hartog.
Cyttalia maculata, Lea.—Fremantle.
Omorophius nigrovarius, n. sp.—Geraldton, Moora, Swan River, Pinjarra, Vasse River, Bridgetown.
Epamaebus ziczac, n. sp.—Denham, Dirk Hartog, Cottesloe, Buckland Hill near North Fremantle, Swan River.
,, *insularis*, n. sp.—Dirk Hartog.

TYCHIIDES.

Elleschodes inconstans, n. sp.—Geraldton, Subiaco, Swan River, Vasse River, Bridgetown, Karridale.

RHINOMACERIDES.

Auletes variipennis, n. sp.—Dirk Hartog.

CRYPTORHYNCHIDES.

Decilaus moluris, Lea.—Torbay.
,, *memnonius*, Pasc.—Geraldton, Moora.
Celidaus michaelseni, n. gen., n. sp.—Geraldton.
Achopera lachrymosa, Pasc.—Harvey, Torbay.

CALANDRIDES.

Calandra oryzae, L.—Denham, Fremantle.

COSSONIDES.

Wollastonicis minutus, n. gen., n. sp.—Denham.

VOLUME II, Part 15.—PISCES.

Part I: SYNGNATHIDAE.

By Dr. Georg Duncker (Hamburg).

Pp. 233-250, with 2 figures in the text.

The author combines with the list of the Western Australian species a list of Syngnathids of all the Australian seas, with short statements of the localities.

Out of the 25 genera of Syngnathids, 15 are found in the Australian seas; of these, *Leptoichthys*, *Halichthys*, *Phyllopteryx* *Stigmatophora*, and *Nannocampus* are peculiar to Australia. Only the W.A. species are summarised here.

Gastrotokeus biaculeatus, L.—N.W. Australia.
Leptoichthys fistularius, Kp.—King George's Sound.
Halichthys taeniophorus, Gray.—Sharks Bay, Freycinet Estuary.
Phyllopteryx foliatus, Shaw.—Fremantle.
(?) *Trachyrrhamphus brevicaudis*, Casteln.—Swan River.
Stigmatophora argus, Richards.—Barrow I., Port Walcott, King George's Sound.
Ichthyocampus galei, n. sp.—Sharks Bay, Freycinet Estuary.
Ichthyocampus scalaris, Gunth.—Sharks Bay, Lagoon Point and Freycinet Estuary.
,, *filum*, Gunth.—Sharks Bay, Freycinet Estuary.
Urocampus guntheri, n. sp.—Sharks Bay, Useless Inlet.
Nannocampus subosseus, Gunth.—Sharks Bay, Freycinet Estuary.
Syngnathus poekilolaemus, Peters.—Barrow I.
,, *philippi*, Lucas.—Albany.
Hippocampus breviceps, Peters.—Fremantle.
,, *angustus*, Gunth.—Sharks Bay, Useless Inlet, Freycinet Estuary.

The following species are insufficiently described:—

Hippocampus elongatus, Casteln.—Fremantle.
,, *subelongatus*, Casteln.—Fremantle.
,, *tuberculatus*, Casteln.—Swan River.

VOLUME II, Part 16. —REPTILIA.

Exclusive of Geckonidae and Scincidae.

By Dr. Franz Werner (Vienna).

Pp. 251-278, with Plates XIV and XV, and 3 figures in the text.

This part deals with the *Reptilia* except the rich material of the families *Geckonidae* and *Scincidae*, which will be treated in another part. The collection contains three new species, a snake of the genus *Pseudechis* and two lizards of the genera *Aprasia* and *Physignathus*.

TESTUDINATA.

Family CHELONIIDAE.

Chelonia mydas, L.—Barrow Island.
Caretta caretta, L.—Bernier Island.

Family CHELYDIDAE.

Chelodina oblonga, Gray.—Albany.

OPHIDIA.

Of the 99 species of snakes known from the Australian continent, only 23, or less than a quarter, have been found in Western Australia. The Hamburg collection contains 12 of these.

Family TYPHLOPIDAE.

Typhlops australis, Gray.—Subiaco, Rottnest.
,, *bituberculatus*, Peters.—?

Family COLUBRIDAE.

(PROTEROGLYPHAE.)

Diemenia psammophis, Schlegel.—Northam.
,, *nuchalis*, Gunther.—Baba Head in Edel-land, Rottnest.
Pseudechis denisonioides, n. sp.—Eradu.
Denisonia coronata, Schlegel.—Subiaco, Jarrahdale, Lunenberg Boyanup, South Albany.
,, *gouldi*, Gray.—W. Australia.
Notechis scutatus, Peters.—Mundijong.
Rhynchelaps bertholdi, Jan.—Subiaco, York.
,, *semifasciatus*, Gunther.—Subiaco.
Furina bimaculata, DB.—Buckland Hill near Fremantle
,, *calonota*, DB.—Subiaco.
Enhydris hardwickii, Gray.—Sharks Bay (Useless Inlet).

The 13 other species recorded from Western Australia are as follows :—

Python spilotes, White.
Diemenia modesta, Gunth.

Pseudelaps diadema, Schleg.

Denisonia punctata, Blngr.

,, *coronoides*, Gunth.

,, *fasciata*, Rosen.

Pseudechis porphyriacus, Shaw.

Brachyaspis curta, Schl.

Elapognathus minor, Gunth.

Rhynchelaps fasciolatus, Gunth.

Furina occipitalis, DB.

Enhydris platurus, Linn.

Enhydris.

LACERTILIA.

Family PYGOPODIDAE.

Pygopus lepidopus, Lac. Upper Blackwood District (Brancaster).

Delma fraseri, Gray. -Tamala in Edel-land, Subiaco, Brunswick, Gooseberry Hill, York, Broome Hill.

,, ,, ,, var. *moelleri*, Lutken.—Eradu, Northampton.

Aprasia pulchella, Gray. —Sharks Bay, Subiaco, York.

,, *brevirostris*, n. sp.—Lion Mill, Donnybrook.

Lialis burtoni, Gray. Subiaco, Buckland Hill near North Fremantle, Rottnest, Kelmscott, York.

Family AGAMIDAE.

Amphibolurus barbatus, Cuvier.—Subiaco.

,, *adelaidensis*, Gray, var *pulcherrima*, Blngr.—W.A.

,, *reticulatus*, Gray.—Denham, Baba Head and Tamala in Edel-land, Northampton, York.

Physignathus eraduensis, n. sp.—Eradu.

Moloch horridus, Gray.—Eradu, Norseman.

Family VARANIDAE.

Varanus caudolineatus, Blngr.—Day Dawn.

Besides these species of *Lacertilia*, 14 (if not 17) others are recorded from W.A.: *Cryptodelma nigriceps*, Fisch.; *C. baileyi*, Gnthr.; *Pletholax gracilis*, Cope.; *Amphibolurus maculatus*, Gray; *A. ornatus*, Gray; *A. cristatus*, Gray; *A. pallidus*, Blngr.; *A. websteri*, Blngr.; and (probably) *A. caudicinctus*, Gnthr.; (*A. pictus*, Peters, and *A. muricatus*, White, according to Lucas and Frost from W.A.), *Physignathus gilberti*, Gray; *P. longirostris*, Blngr.; *Varanus gouldi*, Gray; *V. punctatus*, Gray; *V. acanthurus*, Blngr.; and *V. brevicauda*, Blngr.

VOLUME II, Part 17. ISOPTERA.

By F. Silvestri (Portici).

Pp. 279-314, with Plates XVI-XXI.

The termites (" white ants ") of Australia have been monographed by Froggatt, who recorded 42 species from Australia, New Zealand and Tasmania. Two of these must be identified with other Australian species. The remaining 40 species seem to be distinct and endemic in the Australian region.

The present collection contains 14 species, 5 of which have already been described by Froggatt, whilst 9 appear to be new. For two of these new species a new genus (*Monodontermes*) is created, and three other new genera, *Schedorhinotermes*, *Drepanotermes* and *Psalidotermes* are created for species which were put into the genera *Rhinotermes* and *Termes* by Froggatt.

To the list and descriptions of the species in the collection from South-Western Australia the author adds a more detailed treatise on the very important genus *Mastotermes*, Frogg., and the descriptions of some extra-Australian species, *Prorhinotermes inopinatus*, n. gen., n. sp., *Mircocerotermes peraffinis*, n. sp. from Samoa,and *Schedorhinotermes dimorphus*, Desn. *robustior* n. subsp. from the Bismarck Archipelago.

Family MASTOTERMITIDAE.

Mastotermes darwiniensis, Frogg.—Kimberley.

Family TERMITIDAE.

Schedorhinotermes (n. gen.) *reticulatus*, Frogg.—Dirk Hartog, Moonyoonooka, Kalgoorlie.
Coptotermes lacteus, Frogg.—Moora, Lion Mill, Guildford, Harvey, Collie, Bunbury, Pickering Brook, Boyanup.
,, *michaelseni*, n. sp.—Guildford, Subiaco, Karrakatta, Mundijong.
Drepanotermes (n. gen.) *perniger*, Frogg.—Geraldton, Eradu.
Psalidotermes (n. gen.) *ferox*, Frogg.—Day Dawn, Moonyoonooka, Jarrahdale, Donnybrook, Broome Hill.
Microtermes kraepelinii, n. sp.—Mundaring Weir.
Monodontermes hartmeyeri, n. gen., n. sp.—Day Dawn.
,, *perarmatus*, n. sp.—Yalgoo.
Hamitermes (?) *heterognathus*, n. sp.—Day Dawn.
Hamitermes obeuntis, n. sp.—Mundaring Weir, Serpentine, Albany.
Microcerotermes distinctus, n. sp.—Coolgardie.
Eutermes apiocephalus, n. sp.—Northampton, Jarrahdale.
,, *fumipennis*, Frogg.—Donnybrook, York, Albany.
,, *occasus*, n. sp.—Wooroloo, Lion Mill, Guildford, East Fremantle, Collie.

VOLUME II, Part 18.—ONYCHOPHORA.

By M. E.-L. Bouvier (Paris).

Pp. 315-328, with 7 figures in the text.

The collection contains specimens of only one species :—

Peripatoides woodwardi, n. sp.—Lion Mill.

This species is remarkable on account of its multiple affinities. It resembles *P. suteri* from New Zealand, *P. orientalis* from Eastern Australia, and *P. occidentalis* (Fletcher) from Western Australia (Bridgetown), the only species formerly known from W.A.

VOLUME II, Part 19.—CEPHALOPODA.

By Dr. Werner Th. Meyer (Hamburg).

Pp. 329-335, with 11 figures in the text.

The small number of species, among which are two new ones, does not suffice for an account of the limits of the geographical region. Of chief interest is the occurrence of *Sepioteuthis mauritiana* and *Sepioloides lineolata* on the coasts of Western Australia, The former species was previously only known from Mauritius, the latter from East and South Australia.

LOLIGINIDAE.

Sepioteuthis mauritiana, Quoy et Gaim.—Albany.

SEPIOLIDAE.

Sepioloidea lineolata, Quoy et Gaim. Western Australia.

SEPIIDAE.

Sepia latimanus, Quoy et Gaim. Sharks Bay (Useless Inlet).
,, *galei*, n. sp.—Sharks Bay off Brown Station, Dirk Hartog.
,, *irvingi*, n. sp.—Cockburn Sound (Port Royal), Warnbro Sound.
,, *sp.*—Cockburn Sound (Port Royal).

The numerous but small immature *Octopodidae* could not be determined.

VOLUME II, Part 20.—HOMOPTERA.

By Prof. Dr. Arnold Jacobi (Dresden).

Pp. 337-345, with 13 figures in the text.

In the preface the author gives a critical historical review of the literature on the Australian *Homoptera*.

The collection from Western Australia contained mature specimens of only 14 species, mostly new ones.

Sextius occidentalis, n. sp.—Dirk Hartog.
Paradorydium michaelseni, n. sp. East Fremantle.
Notocephalius hartmeyeri, n. gen., n. sp. -Dirk Hartog.
Eurymela rubrovittata, A. S.—Boorabbin.
Eurymeloides acmaeops, n. sp.—Mundaring Weir.
,, *lenis*, n. sp.—Lion Mill.
Ipo torpens, n. sp.—Monger's Lake.
,, *procurrens*, n. sp.—Boyanup.

Tartessus occidentalis, n. sp.—Dirk Hartog.
Deltocephalus arunda, n. sp.—Moora.
Siphanta lucindae, Kirkaldy.—Karrakatta, Fremantle.
Busas dissolutus, n. gen., n. sp.—Subiaco.
Bunduica rubrovenosa, n. gen., n. sp.—Torbay.

VOLUME II, Part 21.—TETRAXONIDA, Part 1.

By Dr. Ernst Hentschel (Hamburg).

Pp. 347-402, with Plates XXII and XXIII, and 29 figures in the text.

In this first part the author treats those groups of sponges which are called according to the nomenclature of Dendy, *Homosclerophora*, *Astrophora* and *Astromonaxonellida*, *i.e.*, all those sponges which either have no true "*microsclerae*," or which have only "*asters*," or which phylogenetically have been derived from sponges with "*asters*." These groups are treated in this part systematically. All geographical reflexions and studies are reserved for the final part of the treatise.

The author then gives a justification of the systematic views adopted in his paper, which differ somewhat from those of other authors. Joining the *Astromonaxonellida* of Dendy with the *Astrophora* of Sollas, and the *Sigmatomonaxonellida* of Dendy with the *Sigmatophora* of Sollas, both groups having been derived from the *Homosclerophora* of Dendy, the author gets the three groups:—*Homosclerophora*, Dendy, *Astrotetraxonida*, nov., and *Sigmatotetraxonida*, nov. The author on this system disregards the *Ceratosa*. This system of the *Tetraxonida* is in accord with the statement that in the order *Tetraxonida* the "*microsclerae*" are of first-rate systematic importance.

Suborder HOMOSCLEROPHORA.

Family OSCARELLIDAE.

Oscarella membranacea, n. sp. Sharks Bay (Surf Point).
,, *tenuis*, n. sp.—Sharks Bay (S.W. of Denham).

Suborder ASTROTETRAXONIDA. nov,

Family PACHASTRELLIDAE.

Dercitus occultus, n. sp.—Sharks Bay (Surf Point).

Family STELLETTIDAE.

Stelletta Tuberosa, n, sp, -Champion Bay near Geraldton
,, *purpurea* Ridl, var. *grisea*, n, var. -Sharks Bay (Middle Bluff,
,, *brevis*, n. sp.—Sharks Bay (Surf Point).
,, ,, var. *lutea*, n. var.—North Fremantle.
,, ,, var. *paupera*, n. var.—Sharks Bay (Surf Point).

Stelletta aurora, n. sp. -Champion Bay near Geraldton.
„ „ var. *arenosa*, n. var.—Champion Bay near Geraldton.
Ecionemia obtusum, Lend. -Sharks Bay (Surf Point), Champion Bay near Geraldton.

Family GEODIIDAE.

Isops membranacea, n. sp. -Sharks Bay (Middle Bluff).
Geodia punctata, n. sp. -Sharks Bay (inner end of the South Passage and Surf Point).

Family EPIPOLASIDAE.

Asteropus simplex, Cart. -Sharks Bay (Surf Point and off Sunday Island).

Family DONATIIDAE.

Donatia ingalli, Bow. –Sharks Bay (six different stations), Cockburn Sound (Port Royal), Koombana Bay (off Bunbury).
„ „ var. *maxima*, n. var.—Sharks Bay (two different stations).
„ *japonica*, Soll. var. *nucleata*, n. var.—Sharks Bay (two different stations), Cockburn Sound, Warnbro Sound, Albany (Oyster Harbour).
„ „ var. *globosa*, n. var.—Cockburn Sound (?).
„ „ var. *albanensis*, n. var.—Albany (Oyster Harbour).
„ *fissurata*, Lend., var. *extensa*, n. var. –Sharks Bay (Middle Bluff).
Tuberella aaptos, O.S.—Sharks Bay (Surf Point).

Family CHONDROSIIDAE.

Chondrilla australiensis, Cart. Sharks Bay (five different stations)
„ *sp.*—Champion Bay near Geraldotn.
Chondrosia reniformis, Nardo. –Sharks Bay (Surf Point).
„ „ var. *rugosa*, n. var.—Turtle Island.

Family SPIRASTRELLIDAE.

Hymedesmia stellata, Bow. var. *centrifera*, n. var. –Sharks Bay (Lagoon Point).
„ *lophastraea*, n. sp.—Sharks Bay (Surf Point).
Spirastrella cunctatrix, O.S. -Koombana Bay (off Bunbury).
„ *tentorioides*, Dendy, var. *australis*, n. var. -Sharks Bay (Middle Bluff).
„ *digitata*, n. sp.—Sharks Bay (Middle Bluff).
Cliona celata, Grant. -Sharks Bay (Middle Bluff and N.N.E. of Heirisson Prong).
„ *margaritiferae*, Dendy. Sharks Bay (off Denham).

Cliona vastifica, Hanc.—Sharks Bay (Useless Inlet), Albany (Oyster Harbour).
,, *carpenteri*, Hanc. var. *gracilis*.—Sharks Bay (N.W. of Denham).
,, *velans*, n. sp.—Sharks Bay (inner end of South Passage).

Family SUBERITIDAE.

Laxosuberites proteus, n. sp. Sharks Bay (five different stations).
,, ,, f. *donatioides*, n.f.—Sharks Bay (Middle Bluff).
,, ,, f. *tectulum*, n.f.—Sharks Bay (Freycinet Estuary).
Terpios australiensis, n. sp.—Sharks Bay (N.W. of Heirisson Prong).
,, *symbioticus*,n. sp.—Sharks Bay (S.W. of Denham and Useless Inlet).
Rhizaxinella australiensis, n. sp. Albany (Oyster Harbour), Bunbury.
,, *radiata*, n. sp.—Albany (Oyster Harbour).

VOLUME II, Part 22.—TURBELLARIA, RHABDOCOELIDA and TRICLADIDA PALUDICOLA.

By Annie Weiss (Graz).

Pp. 403-410.

The present treatise only gives descriptions of the external characters of the species, the anatomical and histological studies are to be published respectively in " Zeitschr. wiss. Zool." and " Arbeiten a.d. Zool. Instit. Graz."

RHABDOCOELIDA.

Mesostoma canum, n. sp.—Broome Hill.
,, *michaelseni*, n. sp.—Boorabbin.
Plagiostomum hartmeyeri, n. sp. Sharks Bay (Freycinet Reach).

TRICLADIDA PALUDICOLA.

Planaria hoernesi, n. sp.—Boyanup.
,, *striata*, n. sp.—Boyanup.
,, *graffi*, n. sp.—Lion Mill.
,, *bohmigi*, n. sp.—Gooseberry Hill.
,, *pinguis*, n. sp.—Jarrahdale.
,, *rava*, n. sp.—Brunswick.

VOLUME II, Part 23.—CHELONETHI.

By Alb. Tullgren (Stockholm).

Pp. 411-415, with 3 figures in the text.

Family CHELIFERIDAE.

Chelifer sabulosus, n. sp.—Dirk Hartog.

Family GARYPIDAE.

Olpium michaelseni, n. sp.—Yalgoo.
Garypinus sp.—Kalgoorlie.

Family CHTHONIIDAE.

Chthonius caecus, n. sp.—Brunswick.

VOLUME II, Part 24. ODONATA.

By Dr. F. Ris (Rheinau).

Pp. 417-450, with 27 figures in the text.

In the summer of 1906-1907, Mr. R. J. Tillyard (Sydney) made an excursion to Western Australia, and published the results of his studies upon the dragon-flies collected by him. The author has combined these data with those of the preesnt materials collected in the year 1905.

The author devotes considerable space to geographical reflections, based upon comparisons of the Western Australian fauna of dragon-flies with those of other regions, especially with those of the southern parts of Africa and of South America. These three faunas have common resemblances and differences. The most pure in character is the South African fauna, which is derived from the tropical Ethiopian fauna. Somewhat more complex is the fauna of southern South America. That of the Atlantic districts corresponds to the South African one, being purely a derivative of the tropical South American fauna, whilst the scarce Chilian fauna has besides a more recent Neotropical portion, a most archaic portion, chiefly isolated forms, which show a certain relationship with those of Australia. The fauna of Western Australia lastly is a pure derivative of the subtropical and extratropical general Australian fauna. But the latter itself does not correspond to the Ethiopian or the Neotropical fauna. It is a mixture of a very archaic portion similar to the Chilian one, but much richer, and a considerable Indomalayan portion, which rapidly decreases southwards.

The author gives a list of all W.A. dragon-flies, with the addition of some species from other Australian districts. In the following report only those from W.A. are mentioned.

Family CALOPTERYGIDAE.

No species of this family is as yet known from W.A., but it seems to the author probable that the typical Australian genus *Diphlebia* may prove to have Western Australian representatives.

Family AGRIONIDAE.

Subfamily Lestinae.

Lestes leda, Selys.—Subiaco, Mundijong.

Lestes io, Selys. –Moora, Subiaco, Bunbury, previously known from Wilgarrup, Bridgetown, Armadale, Margaret River.

,, *psyche*, Hagen.—Known from Perth, Armadale, Margaret River.

,, *annulosus*, Selys. –Known from Perth, Bridgetown.

,, *analis*, Rambur.—East Fremantle, Serpentine, Brunswick, Busselton, previously known from Swan River.

Subfamily AGRIONINAE.

Argiolestes minimus, Tillyard. Margaret River, previously known from Bridgetown, Wilgarrup, Albany.

Ischnura aurora, Brauer. -Subiaco, Wilgarrup ; prevoiusly known from W.A.

Xanthagrion erythroneurum, Selys.—Perth ; previously known from Perth.

,, *coeruleum*, Tillyard.—Monger's Lake near Subiaco, Perth ; previously known from Perth, Armadale, Bridgetown, Wilgarrup, Margaret River.

Family AESCHNIDAE.

Subfamily GOMPHINAE.

Austrogomphus collaris, Selys.—Known from W.A.

,, *occidentalis*, Tillyard.—Known from Margaret River.

Austroaeschna anacantha, Tillyard. — Wilgarrup ; previously known from Armadale, Waroona, Bridgetown, Wilgarrup, Margaret River.

,, *inermis*, Martin.—Known from W.A.

Aeschna brevistyla, Rambur.- Subiaco ; previously known from W.A.

Anax papuensis, Burm.– Subiaco ; previously known from W.A.

Family LIBELLULIDAE.

Subfamily CORDULINAE.

Synthemis macrostigma, Selys. Known from Swan River, Wilgarrup, Bridgetown.

,, *cyanitincta*, Tillyard.—Known from Margaret River Armadale.

,, *martini*, Tillyard.—Known from Bridgetown, Margaret River, Perth.

Hemicordulia australiae, Rambur.—Known from Swan River.

,, *tau*, Selys.—Subiaco ; previously known from W.A.

Procordulia jacksoniensis, Rambur.— Known from W.A.

,, *affinis*, Selys.—Subiaco, Serpentine ; previously known from Wilgarrup, Margaret River.

Subfamily LIBELLULINAE.

Orthetrum caledonicum, Brauer. Subiaco ; previously known from Perth.

Nannophya dalei occidentalis, Tillyard. Known from Wilgarrup.

Diplacodes bipunctata, Brauer.—Subiaco; previously known from Perth, Armadale, Waroona, Bridgetown.

,, *haematodes*, Burm. Known from Armadale, Waroona, Margaret River, Albany.

Austrothemis nigrescens, Martin. Monger's Lake near Subiaco; previously known from Perth, Armadale, Margaret River, Fremantle.

Pantala flavescens, Fabr.—Known from Waroona.

Tramea limbata, Desjard (forma). Known from Perth.

To this account of the imagines the author adds the descriptions of several larvae :—

Lestes sp.	A.—Vasse River near Busselton.
,, *sp.*	B.—Boyanup.
Aeschninae	C.—Jarrahdale.
,,	D.—Monger's Lake near Subiaco.
Cordulinae	E.—Serpentine River.
,,	F.—Yalgoo.

VOLUME II, Part 25. REPTILIA (GECKONIDAE and SCINCIDAE).

BY DR. FRANZ WERNER (VIENNA).

Pp. 451-493, with 7 figures in the text.

In this part the author completes the description of the Western Australian *Reptilia*, the first part of which was published in part 16 of this volume.

LACERTILIA.

Family GECKONIDAE.

Nephrurus platyurus, Blngr.—Denham.

Gymnodactylus miliusii, Bory.—Subiaco; previously known from Champion Bay.

(*G. platyurus*, White, may also occur in W.A.)

Heteronota binoei, Gray. Denham, Eradu, Kalgoorlie; previously known from the Houtman's Abrolhos, Champion Bay, and Barrow Range.

Phyllodactylus marmoratus, Gray.—Lion Mill, Mundaring Weir, Subiaco, Cottesloe, Harvey, Collie, Bunbury, Boyanup, Cranbrook, Torbay, S. Albany ;, previously known from W.A.

,, *affinis*, Blngr. (?)—Guildford, Subiaco, East Fremantle, Harvey, Yallingup.

,, *ocellatus*, Gray.—Boorabbin; previously known from Houtman's Abrolhos.

Diplodactylus spinigerus, Gray.—Buckland Hill near North Fremantle; previously known from Houtman's Abrolhos, Champion Bay.

Diplodactylus intermedius, Ogilby. -Day Dawn.

,, *vittatus*, Gray.—Gooseberry Hill, York, Broome Hill ; previously known from Houtman's Abrolhos, Champion Bay.

,, *polyophthalmus*, Gunther. Gooseberry Hill, Pickering Brook ; previously known from Champion Bay, Nicol Bay.

,, *michaelseni*, n. sp.—Denham.

,, *pulcher*, Stdchr.—Boorabbin, Beverley ; previously known from W.A.

,, ,, var. *dorsalis*, n. var.—Eradu.

,, *alboguttatus*, n. sp.—Denham.

Gehyra variegata, DB. -Baba Head and Tamala in Edel-land, Northampton, Geraldton, Day Dawn, Yalgoo, Eradu, Dongarra, Moora, Kalgoorlie, Boorabbin, Northam, York, Gooseberry Hill.

Besides these species of *Geckonidae*, the following are known from W.A. : *Rhynchoedura ornata*, Gnthr., from Nicol Bay ; *Phyllodactylus guentheri*, Blngr., from Champion Bay ; *Gehyra australis*, Gray, from Swan River ; *Diplodactylus bilineatus*, Lucas and Frost ; *D. stenodactylus*, Blngr., from Roebuck Bay, in N.W. Australia ; and probably *Oedura lesueuri*, DB.

Family SCINCIDAE.

Trachysaurus rugosus, Shaw.—Tamala in Edel-land, Northam, Rottnest, York ; previously known from King George's Sound, Houtman's Abrolhos, Dirk Hartog, Sharks Bay.

Egernia kingii, Gray. -Rottnest, Torbay, Lunenberg, S. Albany, N.W. Australia ;, previously known from Dirk Hartog, Houtman's Abrolhos, Swan River.

,, *pulchra*, n. sp.—Lunenberg, Torbay, S. Albany.

,, *depressa*, Blngr. W.A., formerly known from Swan River and Murchison district.

Lygosoma (*Hinulia*) *ocelliferum*, Blngr. Beverley, York ; previously known from Roebuck Bay in N.W. Australia.

,, ,, *lesueurii*, D.B.—Eradu, Rottnest, York.

,, ,, *labillardieri*, Gray. -Lion Mill, Jarrahdale, Lunenberg, Donnybrook, Pickering Brook, Torbay, Albany, S. Albany ; previously known from King George's Sound, Swan River, Albany.

,, (*Liolepisma*) *mustelinum*, O'Sh.—Western Australia.

,, ,, *trilineatum*, Gray.—Albany, Bridgetown ; formerly known from Swan River, Albany.

Lygosoma (*Homolepida*) *branchiale*, Gnthr. Boorabbin; known previously from W.A. and N.W. Australia.
,, ,, *australe*, Gray.—S. Albany; previously known from Swan River and King George's Sound.
,, (*Hemiergis*) *initiale*, n. sp.—Lion Mill, Jarrahdale.
,, ,, *quadridigitatum*, n. nom. (pro *peronii* Fitz.). Bridgetown, Yallingup, Torbay ,Albany, S. Albany; previously known from Albany, King George's Sound.
,, ,, *decresiense*, Fitz. Lunenberg, Donnybrook.
,, ,, *quadrilineatum*, D.B.—Subiaco, Buckland Hill near North Fremantle, East Fremantle, Fremantle, Rottnest, Bunbury; previously known from the Houtman's Abrolhos, Champion Bay and Swan River.
,, (*Rhodona*) *lineopunctulatum*, D.B. Subiaco; previously known from Swan River.
,, ,, *bipes*, Fischer. Denham, Tamala in Edelland; previously known from Nicol Bay.
,, ,, *praepeditum* Blngr. Subiaco, Buckland Hill near North Fremantle, Rottnest; previously known from Western Australia.

Ablepharus boutoni, Desj. var. *peroni*, Coct. Eradu, Kalgoorlie, Boorabbin, Mundaring Weir, Guildford, Subiaco, York; previously known from Swan River.
,, *lineo-ocellatus*, D.B. Northampton, Mundaring Weir, Subiaco, Rottnest, Boyanup, S. Albany; previously known from Swan River.
,, *taeniopleurus*, Ptrs.—Kalgoorlie, Boorabbin.
,, *greyi*, Gray. Wooroloo, Mundaring Weir, Guildford, Fremantle, York, Beverley; previously known from Swan River.
,, *distinguendus*, n. sp.—Fremantle.
,, *elegans*, Gray.—Rottnest; formerly known from W.A.

Besides the species of this list, the following *Scincidae* are known from Western Australia:—

Tiliqua occipitalis, Ptrs. (Swan River), *Egernia luctuosa*, Ptrs., *E. whitei*, Lac. (Swan River and Houtman's Abrolhos), *E. cunninghami*, Gray (29' s. l.), *E. stokesii*, A. Dum. (Houtman's Abrolhos, Dirk Hartog), *E. inornata*, Rosen, *E. dahlii*, Blngr. (Roebuck Bay, N.W. Australia), *Lygosoma* (*Hinulia*) *fischeri*, Blngr. Nicol Bay), *L.* (*H.*) *pallidum*, Gnthr. (Nicol Bay), *L.* (*H.*) *isolepis*, Blngr. (Nicol Bay, Swan River), *L.* (*H.*) *richardsoni*, Gray (Houtman's Abrolhos), *L.* (*H.*) *monotropis*, Blngr. (Champion Bay), *L.* (*H.*)

colleti, Blngr. (Robeuck Bay), *L.* (*Homolepida*) *gastrostigma*, Blngr. (Sherlock River, Nicol Bay), *L.* (*Liolepisma*) *guichenoti*, D.B. (Swan River), *L.* (*Rhodona*) *microtis*, Gray (Swan River), *L.* (*R.*) *gerrardi*, Gray (Swan River, Champion Bay), *L.* (*R.*) *miopus*, Gthr. (Champion Bay), *L.* (*R.*) *walkeri*, Blngr. (Roebuck Bay, Condillac Island), *Ablepharus muelleri*, Fisch., *A. lineatus*, Bell.

VOLUME III, Part 1.—ALCYONARIA, Part 1.

By Prof. W. Kukenthal (Breslau).

Pp. 1-108, with Plates I-IV, and 52 figures in the text.

The present part deals with the whole of the group *Alcyonacea* and a portion of the *Gorgonacea*. Most of the specimens were collected in the shallow littoral waters of Sharks Bay. From a zoogeographical point of view the great number of new species, principally of the family *Nephthyidae*, is remarkable, as well as the rich development of species of the genera *Nephthya* and *Stereonephthya*. Besides these, the new genus *Nephthyigorgia* may have its centre of development in Western Australia (*Entstehungs zentrum*)

In the following list only the species from Western Australia are mentioned, but the author adds to these accounts of many extra-Australian forms.

Family ALCYONIIDAE.

Sarcophytum latum, Dana.—Turtle Island.
,, *acutangulum*, Marenz. Port Hedland and Freycinet Reach, Sharks Bay.
Alcyonium pachyclados, Klzgr. -Turtle Island, Sharks Bay.
Telesto multiflora, Laackmann.—Sharks Bay.

Family NEPHTHYIDAE [ver].

Nephthya aurantiaca, Verrill. Sharks Bay (Sunday Island).
,, *digitata*, Wr. Stud.—Sharks Bay (South Passage).
,, *granulata*, n. sp. Sharks Bay (off Heirisson Prong).
,, *complanata*, n. sp. Sharks Bay (off Heirisson Prong and Useless Inlet).
,, *hartmeyeri*, n. sp. Sharks Bay (off Heirisson Prong and Useless Inlet).
,, *quercus*, n. sp. Sharks Bay (off Heirisson Prong).
,, *rubra*, n. sp.—Sharks Bay (Useless Inlet).
,, *australis*, n. sp.—Sharks Bay (off Heirisson Prong).
,, *corallina*, n. sp.—Port Hedland.
Dendronephthya florida, Esp. -Sharks Bay (Freycinet Reach).
,, *michaelseni*, n. sp.—North-Western Australia.
,, ,, var. n. *laevis*.—Barrow Island, Port Hedland.

Dendronephthya, sp. (near *umbellata*, Wr. Stud.). Sharks Bay (Freycinet Reach).
Stereonephthya whiteleggei, Kukth. -North-Western Australia.
,, *armata*, n. sp.—Sharks Bay.
,, *ochracea*, n. sp.—Western Australia.

Family SIPHONOGORGIIDAE.

Nephthyigorgia, n. gen. *crassa*, n. sp. Sharks Bay (Freycinet Reach).
,, *pinnata*, n. sp.—South-Western Australia.
,, *aurantiaca*, n. sp.—South-Western Australia.

Family FASCICULARIIDAE (Viguier).

Studeriotes crassa, n. sp. Sharks Bay (off Heirisson Prong), Houtman's Abrolhos.

Family PLEXAURIDAE. (Gray)

Euplexaura albida, Kukth. Sharks Bay (Freycinet Reach).
Plexauroides michaelseni, Kukth. Sharks Bay (off Heirisson Prong).
,, *rigida*, Kukth. Sharks Bay (off Heirisson Prong).
,, *simplex*, Kukth.—North-Western Australia.
,, *filiformis*, Kukth.—Sharks Bay (Freycinet Reach).

Family MELITODIDAE. (Verr).

Mopsella klunzingeri, Kukth. Oyster Harbour, near Albany.
,, *sanguinea*, Kukth.—Rottnest (Green Island).
Clathraria akalyx, Kukth. Sharks Bay (off Heirisson Prong).

VOLUME III, Part 2. -PENNATULIDA.

By Hjalmar Broch (Christiania).

Pp. 109-122, with Plate V, and 9 figures in the text.

Only two species occur in the collection :

Pterocides hymenocaulon, Bleeker. Sharks Bay (Heirisson Prong)
Sarcophyllum roseum, n. sp. Middleton Beach near Albany.

VOLUME III, Part 3. CHAETOGNATHA.

By Dr. R. v. Ritter-Zahony (Berlin).

Pp. 123-126.

All the specimens were collected in the tropical Sharks Bay, whilst the plankton samples in the more southern coastal regions, in spite of their richness in other animals, principally in *Copepods*, contained no specimens of *Chaetognatha*. The character of the Chaetognathid-fauna of Sharks Bay is entirely tropical, especially tropical Indo-Pacific.

Sagitta bedoti, Beraneck. Sharks Bay (Denham).

Sagitta bipunctata, Q. and G., forma *typica*, Ritt.-Z.—Sharks Bay (Denham).
,, *enflata*, Grassi.—Sharks Bay (South Passage).
,, *minima*, Grassi.—Sharks Bay (Denham).
,, *pulchra*, Doncaster.—Sharks Bay (Denham).
,, *regularis*, Aida.—Sharks Bay (Denham).
,, *robusta*, Doncaster.—Sharks Bay (Denham).
,, *serratodentata*, Krohn.—Sharks Bay (Denham).
Spadella draco, Krohn.—Sharks Bay (Denham).
Krohnitta subtilis, Grassi.—Sharks Bay (Denham).

VOLUME III, Part 4.—OPILIONES.

By Dr. J. C. C. Loman (Amsterdam).

Pp. 127-134.

The collection contained no mature specimens, only immature ones. This circumstance is probably due to the season in which the collection was made July to November. Probably the time of sexual maturity is confined to the season from January to April.

The author was only able to determine one nearly mature specimen :—

Triaenonyx aspera, Pocock (?).—Pinjarra, Lunenberg, Brunswick, and Bridgetown.

VOLUME III, Part 5.—SPONGILLIDAE.

By Dr. W. Weltner (Berlin).

No freshwater sponge was previously known from W.A. But from the Eastern States of the continent some species were described, which are enumerated by the author. This list of Australian freshwater sponges, containing nine species from Queensland, New South Wales, Victoria and South Australia, is now augmented by a tenth, a new species, from W.A., the first known from this State :—

Ephydatia multiformis, n. sp.—Herdsman's Lake near Subiaco.

VOLUME III, Part 6.—MYRIOPODA, excl. Scolopendridae.

By Dr. Carl Graf Attems (Vienna).

Pp. 145-204, with 110 figures in the text.

Excluding the family *Scolopendridae*, only two species of *Myriopoda* were formerly known from W.A., viz., *Henicops dentatus*, Pocock, and *Eurytion concolor*, Gerv., both from Perth, Of the 45 species of this collection (incl. *Scolopendridae*) 30 are new, and seven new genera had to be created for the reception of some of them.

The most interesting zoogeographical fact derived from the study of the collection was the occurrence of *Lamyctes africana*, Poc., and *Monographis schultzei*, Att. in W.A., species which previously were known only from South and from South-Western Africa respectively.

The absence of any *Spirobolid* and *Sphaerotherii* in the collection is remarkable. These large and striking forms are generally the first to be obtained by collectors. They seem to be absent from the districts examined by Michaelsen and Hartmeyer.

SCUTIGERIDAE.

Allothereua maculata, Newp. Subiaco, East Fremantle, Jarrahdale, Harvey, Collie, Bunbury, Brancaster, Bridgetown, Donnybrook, Boyanup, Yallingup, South Albany.

LITHOBIIDAE.

Lamyctes fulvicornis, Mein. Day Dawn, Mundaring Weir, Pinjarra, York, Beverley.

,, *africana*, Pocock. Kalgoorlie, Donnybrook, Cranbrook, and Albany.

Henicops oligotarsus, n. sp. Wooroloo, Lion Mill, Mundaring Weir, East Fremantle, Jarrahdale, Brunswick, Bridgetown, Boyanup, Gooseberry Hill, Beverley, and Albany.

,, *dentatus*, Pocock, from Perth, not contained in the collection.

Dichelobius flavens, n. gen., n. sp.—Eradu, Lion Mill, Jarrahdale, Donnybrook, Gooseberry Hill.

(SCOLOPENDRIDAE.)

See: K. Kraepelin, *Scolopendridae*, in Vol. II, Part 8.

GEOPHILIDAE.

Lamnonyx tahitiensis, Wood.—Tamala, Northampton, Eradu, Wooroloo, Lion Mill, Guildford, Subiaco, East Fremantle, Cannington, Jarrahdale, Collie, Bunbury, Donnybrook, Gooseberry Hill, York, Cranbrook, Torbay, and Albany.

Orphnaeus brevilabiatus, Newp. Helen River, Gooseberry Hill.

Geophilus hartmeyeri, n. sp. Denham, Eradu and Albany.

Eurytion (*Steneurytion*) *incisunguis*, n. sp.—Harvey.

,, *sitocola*, Att.—Collie.

,, *concolor*, Gerv., known from Perth, not represented in collection.

Polygonarea imparata, n. sp. Lion Mill, Mundaring Weir, Subiaco, Karrakatta, East Fremantle, Collie, Boyanup, Pickering Brook.

Polygonarea repanda, n. sp. *multipes*, n. subsp.—Wooroloo, Mundaring Weir, Fremantle, Cannington, Jarrahdale, Serpentine.

,, ,, *conifera*, n. subsp.—Yalgoo, Dongarra, Mundijong, Brunswick, Bridgetown, Gooseberry Hill, York, Broome Hill, Cranbrook.

SYMPHYLA.

Scutigerella indecisa, n. sp.—Lion Mill, Guildford, Harvey, Brunswick, Boyanup, Gooseberry Hill.

PSELAPHOGNATHA.

Monographis schultzei, Att.—Torbay.

POLYDESMOIDEA.

Antichiropus, n. gen., *variabilis*, n. sp., *ingens*, n. subsp.—Wooroloo, Lion Mill, Mundaring Weir, Guildford, East Fremantle, Cannington, Harvey, Collie, Brand caster, Bridgetown, Donnybrook, Boyanup, Gooseberry Hill, Pickering Brook, and York.

,, *nanus*, n. subsp.—Boyanup, Yallingup.

,, *minimus*, n. sp.—Mundaring Weir, Jarrahdale.

. *whistleri*, n. sp.—Buckland Hill near North Fremantle, Rottnest, Brancaster in Upper Blackwood District.

,, *monacanthus*, n. sp.—Dirk Hartog, Tamala in Edelland, and Wooroloo.

,, *fossulifrons*, n. sp.—Yalgoo, Eradu.

,, *sulcatus*, n. sp.—Guildford.

Orthomorpha triaina, n. sp.—Albany.

Sphaerotrichopus ramosus, n. gen., n. sp.—Wooroloo, Lion Mill, Mundaring Weir, Rottnest, Gooseberry Hill, Pickering Brook.

JULOIDEA.

Family CAMBALIDAE.

Podykipus collinus, n. gen., n. sp.—Subiaco, East Fremantle, Gooseberry Hill.

,, *leptoiuloides*, n. sp.—Lion Mill, Mundaring Weir, Jarrahdale, Collie, Pickering Brook.

Dinocambala ingens, n. gen., n. sp.—Gooseberry Hill.

Atelomastix albanyensis, n. gen., n. sp.—Albany.

,, *nigrescens*, n. sp.—Jarrahdale, Lunenberg.

Samichus decoratus, n. gen., n. sp.—Torbay.

COLOBOGNATHA.

Orsilochus michaelseni, n. sp. -Bridgetown, Yallingup.
Siphonotus flavomarginatus, n. sp.—Torbay.

VOLUME III, Part 7.—SERPHIDAE and EVANIIDAE.

By Prof. J. J. Kieffer (Bitsch in Lothringen).

Pp. 205-211.

The collection of *Serphidae* (*Proctotrypidae*) and *Evaniidae* is small, containing only four specimens, the types of four new species. Two of these are of special interest, one of them, an *Aclista*, being the first Australian representative of its genus, and even of the whole subfamily *Belytinae*, the other being the first species of the subfamily *Serphinae* to be recorded, not only from Australia, but from the whole Australian region.

Family SERPHIDAE (PROCTOTRYPIDAE).

Aclista australiensis, n. sp.—Subiaco.
Serphus australiae, n. sp.—Guildford.
Rhabdepyris australiae, n. sp.—Boyanup.

Family EVANIIDAE.

Hyptiogaster crassitarsis, n. sp.—Subiaco.

VOLUME III, Part 8. ACTINIARIA.

By Ester Lager (Stockholm).

Pp. 213-249, with 22 figures in the text.

The author makes some remarks upon the distribution of the Australian *Actiniaria*. The *Stichodactylinae* (eight species) occur only in the tropics or in the zone just south of the tropics. The *Protostichodactylinae*, of which species from the tropics and subtropic regions, as well as from New Zealand, have been recorded, are not represented in this collection. The genera *Boloceroides*, *Isactinia* and *Gyrostoma* are tropical forms, so that the occurrence of *Gyrostoma haddoni* as far south as Fremantle is remarkable. The families *Aliciidae*, *Tealidae* and *Sagartidae*, which are all represented in the collection, occur in the tropical and subtropical regions, as well as in New Zealand. The family *Phyllactidae* is represented in W.A. by three species of the genus *Saccactis*, mostly from the southern part of W.A. (Bunbury and Albany), but one specimen comes from tropical Sharks Bay. Besides these only species of *Crodactis* have been recorded from the Australian Region (New Zealand). It is to be remarked that at present no Australian representative of the *Athenariidae* is recorded, whilst three species of this family occur in New Zealand.

Family GONACTINIDAE.

Boloceroides memurrichi (Kwietn.), Carlgr.—Sharks Bay (Sunday Island).

Family ALICIIDAE.

Cystiactis tuberculosa (Q. and G.) Haddon.—Koombana Bay near Bunbury.

Family PHYLLACTIDAE.

Saccactis mcmurrichi, n. gen., n. sp.—Off Casuarina Point near Bunbury.
,, ,, var.—Albany.
,, *australis*, n. sp.—Sharks Bay (Denham) and Albany.
,, *musculosa*, n. sp.—Albany.

Family ACTINIIDAE.

Isactinia carlgreni, n. sp.—Cossack, Sharks Bay (Denham).
Gyrostoma haddoni, n. sp.—Rottnest (Green Island).
,, *sulcatum*, n. sp.—Sharks Bay (Surf Point).

Family TEALIDAE.

Cribrina verruculata, n. sp.—Rottnest.
,, *altifossa*, n. sp.—Sharks Bay (Surf Point).

Family PHYMANTHIDAE.

Phymanthus muscosus, Haddon.—Turtle Island.

Family STOICHACTIDAE.

Stoichactis intermedia, n. sp.—North-Western Australia.
,, *laevis*, n. sp.—Sharks Bay (Denham).
,, *australis*, n. sp.—Sharks Bay (Surf Point).
Antheopsis carlgreni, n. sp.—Sharks Bay (Surf Point).
,, *concinnata*, n. sp.—Sharks Bay (Useless Inlet).
Stichodactis glandulosa, n. sp.—Broome.
,, *kwietniewskii*, n. sp.—Barrow Island.

VOLUME III, Part 9. PHYLLOPODA.

By Dr. E. Wolf (Frankfurt a.M.).
Pp. 251-276, with 24 figures in the text.

The author gives a list of the previously known species from the Australian region (including Tasmania and New Zealand), the number of which, about 30, will certainly be diminished by a revision of type specimens, many of the descriptions in question being very poor and some of the species undoubtedly being only synonyms of others.

It is remarkable that most of the species in the present collection are new ones, or at least aberrant forms, and probably confined to the Australian continent. Among all the Australian *Phyllopods* we know only one, *Cyclestheria hislopi*, which is said to occur also in other continents. But it seems questionable to the author whether the South American, Indian and African representatives of this species might not prove on more exact study to be different from the Australian form.

The following list is confined to the species from W.A., but the author includes in his paper some species from other parts of the Australian region.

ANOSTRACA.

Family BRANCHIPODIDAE.

Branchinella eyrensis, Sayce.—Hannan's Lake near Kalgoorlie.
,, *longirostris*, n. sp.—Boorabbin.

NOTOSTRACA.

Family TRIOPSIDAE.

Triops gracilis, n. sp.—Hannan's Lake near Kalgoorlie.
Lepidurus viridis, Baird, n. var. *elongatus*. Broome Hill.

CONCHOSTRACA.

Family LIMNADIIDAE.

Eulimnadia badia, n. sp.—Boorabbin.

VOLUME III, Part 10.—TETRAXONIDA.

By Dr. Ernst Hentschel (Hamburg).
Pp. 277-399, with 54 figures in the text.

The present part of the *Tetraxonida* of W.A. deals with the tribe *Sigmatophora* and the family *Desmacidonidae* of the tribe *Sigmatomonaxonellida*, both tribes belonging to the suborder *Sigmatotetraxonida*.

Suborder SIGMATOTETRAXONIDA.

Tribe SIGMATOPHORA.

Family TETILLIDAE.

Tetilla cinachyroides, n. sp.—Western Australia, Barrow Island.
Cinachyra malaccensis, Soll.—Cossack.
,, *phacoides*, n. sp.—Sharks Bay (Middle Bluff).
Tethyopsilla zetlandica, Cart.—Sharks Bay (Outer Bar).

Tribe SIGMATOMONAXONELLIDA.

Family DESMACIDONIDAE.

Mycale cockburniana, n. sp.—Cockburn Sound (Port Royal).
  „ „ f. n. *albanensis*.—Oyster Harbour near Albany.
  „ *raphidiophora*, n. sp.—Oyster Harbour near Albany.
  „ *fistulata*, n. sp.—Sharks Bay (off Denham).
  „ „ var. *macrochela*, n.—Sharks Bay (South Passage).
  „ *phyllophila*, n. sp.—Sharks Bay (off Denham and Freycinet Reach).
  „ *macilenta*, Bow. var. n. *australis*.—Sharks Bay (Middle Bluff and Freycinet Reach).
  „ *isochela*, n. sp.—Sharks Bay (Freycinet Estuary), Fremantle.
  „ *pectinicola*, n. sp.—Sharks Bay (several stations).
  „ *obscura*, Cart.—Sharks Bay (Freycinet Reach and off Dirk Hartog Island).
  „ *moluccensis*, Thiele, f. n. *dichela*.—Sharks Bay (Useless Inlet and South Passage).
  „ *sulcata*, n. sp.—Oyster Harbour, near Albany.
  „ „ nar. n. *minor*.—Cottesloe Beach.
  „ *parasitica*, Cart. var. n. *arenosa*.—Champion Bay off Geraldton.
Esperiopsis hispidula, Ridl. var. n. *ramosa*.—Sharks Bay (Freycinet Estuary).
Desmacella arenifibrosa, n. sp.—Koombana Bay off Bunbury.
Biemma microxa, n. sp.—Sharks Bay (Middle Bluff and Sunday Island).
Homoeodictya staurophora, n. sp.—Geographe Bay, Middleton Beach near Albany.
  „ *dendyi*, Whit.—Fremantle, and Middleton Beach near Albany.
Desmacidon plicatum, n. sp.—Western Australia.
  „ *psammodes*, n. sp.—Sharks Bay (off Denham).
Batzella inaequalis, n. sp.—Sharks Bay (off Denham) and Oyster Harbour near Albany.
Lissodendoryx tuberosa, n. sp.—Sharks Bay (off Denham).
Dendoricella schmidti, Ridl.—Cockburn Sound (Port Royal).
Iotrochota baculifera, Ridl. var. n. *minor*.—Sharks Bay (several stations).
  „ *acerata*, Dendy, var. n. *palmata*.—Fremantle.
Tedania digitata, O.S.—Sharks Bay, Busselton, and Middleton Beach near Albany.
  „ „ f. n. *inermis*.—Sharks Bay and Cockburn Sound.
  „ „ f. n. *polytyla*.—Sharks Bay (Lagoon Point).
  „ *rubicunda*, Lendf.—Champion Bay off Geraldton.
  „ *bispinata*, n. sp.—Koombana Bay off Bunbury, and Oyster Harbour near Albany.

Forcepia michaelseni, n. (pro *colonensis*, cart.) —Rottnest.
,, *arenosa*, n. sp.—Koombana Bay off Bunbury.
Grayella spinulata, n. sp. —Sharks Bay (Inner Bar and South Passage).
Ectyodoryx maculatus, n. sp.—Oyster Harbour near Albany.
Crella incrustans, Cart., n. subsp. *thielei*.—Sharks Bay, Cottesloe Beach, Koombana Bay off Bunbury, and Oyster Harbour near Albany.
Microciona acerato-obtusa, Cart. —Sharks Bay (several stations).
Hymeraphia graphidiophora, n. sp. —Champion Bay off Geraldton.
,, *michaelseni*, n. sp.—Sharks Bay (Denham).
Leptosia grisea, n. sp.—Sharks Bay (Middle Bluff).
,, *oculifera*, n. sp.—Fremantle.
,, *australiensis*, n. sp.—Sharks Bay (Freycinet Reach and off Heirisson Prong).
,, *baculifera*, Tops., var. n. *australiensis*.—Sharks Bay (Inner Bar).
,, *dichela*, n. sp.—Sharks Bay and Fremantle.
,, *simplicissima*, n. sp.—Sharks Bay (Freycinet Estuary).
Leptolabis tenuissima, n. sp.—Sharks Bay (Middle Bluff).
Spanioplon cheliferum, n. sp.—Western Australia.
Clathria typica, Cart.—Sharks Bay (Sunday Island), Fremantle, Geographe Bay, Middleton Beach and Oyster Harbour near Albany.
,, *acanthodes*, n. sp.—Sharks Bay (Surf Point).
,, *dura*, Whitel.—Geographe Bay.
,, ,, n. var. *mollis*.—Sharks Bay (Freycinet Reach) and Geographe Bay.
,, *elegantula*, R. and D., var. n. *occidentalis*.—Sharks Bay (Inner Bar).
,, *australiensis*, Cart., var. n. *spinulata*.—Geographe Bay, and Middleton Beach near Albany.
,, *alata*, Dendy.—Oyster Harbour near Albany.
,, *tenuis*, Cart.—Cottesloe Beach and Geographe Bay.
,, *hartmeyeri*, n. sp.—Sharks Bay (Sunday Island), Geographe Bay.

Raspailia paradoxa, n. sp.—South-western Australia.
,, (*Syringella*) *nuda*, n. sp.—Sharks Bay (off Heirisson Prong).

Echinodictyum bilamellatum, Lam.—Sharks Bay, Dongarra and Koombana Bay off Bunbury.
nidulus, n. sp.—Sharks Bay (off Dirk Hartog Island).
,, *clathriodes*, n. sp.—Sharks Bay (off Middle Bluff and Freycinet Estuary).
,, *fruticosum*, n. sp.—Sharks Bay (South Passage).

Agelas axifera, n. sp.—Champion Bay near Geraldton.

VOLUME III, Part 11.—POLYPHACOPHORA.

By Prof. J. Thiele (Berlin).

Pp. 295-406, with Plate VI.

The collection contains 19 species, of which seven are new. These species belong throughout to genera which are known from the Australian coasts, and may be assigned to the Indo-Pacific fauna, whilst there are no forms characteristic ot the Antarctic seas.

Onithochiton scholvieni, Thiele.—Rottnest (Green Island, and Koombana Bay off Bunbury.
Lucilina dilecta, n. sp. Sharks Bay (several stations).
Acanthopleura spinigera, Sowerby.—Bernier Island, Cossack, and Turtle Island.
,, (*Liolophura*) *georgiana*, Q. and G.—Dongarra and Albany.
Ischnochiton (*Heterozona*) *cariosus*, Carpenter. -Koombana Bay off Bunbury.
,, *ustulatus*, Reeve.—Rottnest, Koombana Bay off Bunbury.
,, *virgatus*, Reeve.—Rottnest, Cockburn Sound and Albany
,, *thomasi*, Bednall.—Bunbury.
,, *albinus*, n. sp.—Sharks Bay (Surf Point).
,, *indifferens*, n. sp.—? Sharks Bay.
Callistochiton recens, n. sp. Sharks Bay (Useless Inlet).
Callochiton rufus, Ashby. Sharks Bay (off Middle Bluff and Heirisson Prong).
Plaxiphora albida, Blainville.—Cottesloe Beach.
Acanthochites sueurii, Blainville.—Albany.
,, *bednalli*, Pilsbry. —Sharks Bay, and Oyster Harbour near Albany.
,, *deliciosus*, n. sp.—Koombana Bay off Bunbury.
Cryptoplax michaelseni, n. sp.—Sharks Bay (off Heirisson Prong).
,, *hartmeyeri*, n. sp.—Sharks Bay (Surf Point).
,, *gunnii*, Reeve.—North Fremantle.

VOLUME III, Part 12.—HIRUDINEA.

By Dr. L. Johansson (Goteborg).

Pp. 407-431, with 10 figures in the text.

The leeches in the collection were caught partly in fresh-water and partly in marine localities. They belong to five different species, two, if not three, of which are new, and one ot which may prove to be the representative of a new genus.

Family ICHTHYOBDELLIDAE.

Pontobdella rayneri, Baird. Sharks Bay (off Denham).
Platybdella michaelseni, n. sp. Cockburn Sound, Warnbro Sound.
Ichthyobdella australiensis, n. sp. Champion Bay off Geraldton.

Family GLOSSOSIPHONIDAE.

Clepsine, n. sp. (?).—Broome Hill (fresh-water).

Family GNATHOBDELLIDAE.

Hirudo australis, Bosisto. -Serpentine, Bunbury and Boyanup (fresh-water).

VOLUME III, Part 13.—CRINOIDEA.

By Austin Hobart Clark (Washington).

Pp. 433-467.

In the first chapter the author deals with the "History of the Study of the West Australian Crinoids, with a brief Survey of the Literature." The following chapters deal with the "Australian Crinoid Fauna" in general, its relation to other extra-Australian faunas, and the more special faunas of the different Australian districts. He gives lists of: The East Indian Crinoids occurring on the coasts of Australia; The Tropical Crinoids confined to Australia; and The Crinoids confined to Southern Australia. The Australian crinoid fauna is divisible into two parts: (1) the tropical, with about 85 per cent. of the species, inhabiting the northern coast and becoming progressively more and more attenuated, extending south on the west coast to Fremantle (32° 00′ S.) and on the east coast to Port Jackson (33° 50′ S.); and (2) the southern, with about 15 per cent. of the species, inhabiting the southern coast and extending northward on the west coast to Sharks Bay (25° 30′ S.) and on the east coast to Broughton Island (32° 37′ S.), and one species to Flinders (14° 10′ S.).

A Summary of the Locality and Depth Records of West Australian Crinoids is followed by the Annotated List of Species.

Suborder OLIGOPHREATA.

Family COMASTERIDAE.

Capillaster multiradiata, Linn.—Known from Dirk Hartog Island, N. of Port Walcott.
Comatulella brachiolata, Lamarck.—Koombana Bay off Bunbury.
Comatula rotalaria, Lamarck.—Known from Holothuria Bank.
,, *etheridgei*, A. H. Clark—Known from Holothuria Bank and Baudin Island.
,, *solaris*, Lamarck—Known from Holothuria Bank.

,, *purpurea*, J. Muller -Turtle Island, Sharks Bay (numerous stations).

,, *pectinata*, Linn. -Known from Holothuria Bank, Bassett-Smith Bank off York Sound, and Baudin Island.

Comaster typica, Loven -Port Hedland, previously known from N. of Port Walcott, Baudin Island and Bassett-Smith Bank.

,, *Comanthina belli*, P. H. Carpenter—Port Hedlan Sharks Bay (Freycinet Reach) ; previously known from Mermaid Reef.

,, (*Bennettia*) *trichoptera*, J. Muller -Koombana Bay off Bunbury ; previously known from King George's Sound.

,, (*Vania*) *annulata*, Bell -Sharks Bay (Sunday Island) ; previously known from Holothuria Bank.

,, ,, *parvicirra*, J. Muller—Known from Bassett, Smith Bank, Cape Baudin and Fremantle.

Family ZYGOMETRIDAE,

Zygometra microdiscus, Bell -Sharks Bay (N.W. of Herission Prong) ; previously known from Lewis I. (Dampier Archipelago), Holothuria Bank, Nicol Bay, and Mermaid Reef.

,, *multiradiata*, P. H. Carpenter—Known from Lewis I. (Dampier Archipelago).

,, *elegans*, Bell—W.A., previously known from Baudin I., and Mermaid Reef.

Family HIMEROMETRIDAE

Amphimetra variipinna, P. H. Carpenter—Known from Holothuria Bank and Baudin Island.

,, *discoidea*, A. H. Clark—W.A., previously known from Holothuria Bank.

Heterometra bengalensis, Hartlaub –Known from Holothuria Bank.

Family MARIAMETRIDAE.

Dichrometra tenera, Hartlaub –Sharks Bay (Freycinet Reach and Inner Bar).

Decametra studeri, A. H. Clark –Known from Dirk Hartog Island.

Oligometra adeonae, Lamarck—Known from Baudin Island.

,, *carpenteri*, Bell -Known from Holothuria Bank, Bassett-Smith Bank, and Baudin Island.

Cenometra cornuta, A. H. Clark –Known from Adele Island.

Family THALASSOMETRIDAE.

Pillometra macronema, J. Muller -Koombana Bay (off Bunbury); previously known from Dirk Hartog Island and King George's Sound.

Suborder MACROPHREATA.

Family ANTEDONIDAE.

Family COLOBOMETRIDAE (Norman) emende. A. H. Clark.

Compsometra incommoda, Bell -Koombana Bay (off Bunbury).

THE FOUNDATION STONES OF WESTERN AUSTRALIA: AN EARLY CHAPTER IN THE GEOLOGICAL HISTORY OF THE STATE. By A. GIBB MAITLAND, F.G.S. (Read October 14th, 1913.)

TIME AND ITS MEASUREMENT. By A. D. ROSS,* M.A., D.Sc., F.R.A.S., F.R.S.E. (Read November 11th, 1913).

A THEORY OF THE METHOD OF THE FORMATION OF AUSTRALITES. By C. G. THORP, M.B., C.M. (Read December 9th, 1913.)

THE LATE DR. ALEX. MORRISON.

Dr. Alexander Morrison, L.R.C.P. and L.R.C.S. (Edinburgh, 1876), was a son of Thomas Morrison, of North Dalmeny, near Edinburgh, and was born there on 15th March, 1849. He became a medical student at the University of Edinburgh. When eighteen years of age he voyaged to Australia for the sake of his health, and resided in Melbourne for two years, continuing his medical studies at the University. Returning to Edinburgh, he graduated there, and also studied in Glasgow, Wurzburg, and Vienna. In 1877 he returned to Australia in medical charge of immigrants in the ship *Hastings*, by which vessel Bishop Parry also came out. Dr. Morrison stayed only a few days in Western Australia, but he went to York and walked most of the way back to Perth, examining the flora, as he was an enthusiastic "systematic" botanist. He went to Melbourne and was *locum tenens* for a year for the doctor of the Ararat Lunatic Asylum, and then started in private practice in Albert Street, East Melbourne, where he remained fifteen years. He then sold his practice, and, after some time spent in travel, in the course of which he examined the botany of the New Hebrides, he returned to Perth and was appointed Botanist in the Bureau of Agriculture, from 1st July, 1897, at a salary of £230 per annum, by Mr. George Throssell, the Commissioner of Crown Lands (Sir John Forrest, Premier). But, unlike the government botanists of the other States, he was not allowed a free pass or clerical assistance, and his opportunities of doing original work were consequently somewhat curtailed. He continued to fulfil the duties of Botanist until 19th June, 1906 ,when the retrenchment of the Government (Mr. C. F. Chaplin being Director of Agriculture and Sir Newton Moore, Premier) rendered the position vacant. He received a reitring allowance of £145 19s. 3d., but no pension, which would have accrued to him after another year's service. He took up private practice again, residing first in Hay Street, near Irwin

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* Professor of Mathematics and Physics in the University of Western Australia.

Street, and afterwards in Rokeby Road, Subiaco; but at the request of the Agricultural Department he continued to perform the work of consulting botanist, somewhat neglecting his medical work, until Dr. Stoward was appointed Botanist and Vegetable Pathologist about a year later.

Dr. Morrison named the botanical specimens at the Museum gratuitously from the year 1906 to the time he left the State. He visited the Stirling Range at the instance of the Government and made a large collection of plants in that part. He contributed several papers to the W.A. Natural History Society and the Natural History and Science Society of W.A., of which he was a member, and, from February, 1913, an honorary member. He gave two Museum lectures, one in 1908 on "The Adaptation of Plants to their Environment," which was noticed and highly commended in *Nature*, the other in 1910 on "Vegetation and Rainfall." He deprecated the wholesale destruction of forests, and advocated forest and botanical reserves. He very carefully revised for the official Year Book of W.A. an account of the vegetation of the State, with a list of the extra-tropical W.A. plants a work of 44 pages, originally prepared by Baron von Mueller in 1894 5, and printed in 1903 in the "Natural History Notes of W.A." in the Year Book. This he revised again in 1912 for the W.A. Museum, but want of funds has prevented its being printed. He was a painstaking worker, and exceedingly cautious, he was reticent, retiring, kindly in his disposition, and scrupulously honest in all his dealings. He was all his life a collector of botanical specimens, and when leaving Perth in 1912 he complained that they alone occupied fifty cases. He received the appointment of Assistant Botanist to Professor Ewart, at the Melbourne Herbarium. When there he was not in good health, never having recovered from a severe attack of influenza that he had in Perth, and the illness developed into tubercle in the throat; but, in spite of his ill-health, he remained at his work until nine weeks before his death, which took place at the Heatherton Sanatorium Cheltenham, on 7th December, 1913. His remains were interred in the Kew Cemetery. He left his herbarium to the Edinburgh University, his medical and botanical books to the Tasmanian University, and the residue of his estate to the Melbourne University.

PROCEEDINGS

OF THE

NATURAL HISTORY AND SCIENCE SOCIETY

OF

WESTERN AUSTRALIA.

SESSIONS 1912-13 AND 1913-14.

ANNUAL GENERAL MEETING.

July 16th, 1912.

Mr. E. S. Simpson, B.E., F.C.S., President, in the Chair.

Miss Margaret Davy, Mr. B. Perry, and Mr. John Nicholson were elected members of the Society.

Dr. C. G. Thorp presented to the library twenty-two books and a number of volumes of the " Journal of the Department of Agriculture of W.A."

It was resolved that the heartiest thanks of the Society be tendered to Mr. Walter Dwyer, M.L.A., for securing a Government grant in aid of the Society's funds.

The following were elected office-bearers for the ensuing year :—

President : Dr. C. G. Thorp, M.B., C.M.
Vice-Presidents : Mr. E. S. Simpson, B.E., F.C.S. ; Dr. Alex. Morrison.
Hon. Secretary : Mr. Maurice A. Browne, B.A.
Hon. Treasurer : Mr. J. J. East.
Members of Council : Mr. A. Gibb Maitland, F.G.S. ; Dr. Frank Tratman, M.D. ; Mr. W. J. Hancock, M.Inst.C.E., M.I.E.E. ; Mr. A. J. Hall ; Mr. A. O Watkins, F.G.S., A.R.S.M.
Auditors : Mr. A. J. Robertson, M.Sc. ; Dr. F. Stoward, D.Sc.

Report of the Council for the Year 1911-12.

Your Council has much pleasure in submitting the Annual Report and Financial Statement for the year ended 30th June, 1912.

The Society's credit balance, which stood at £32 11s. 4d. at the beginning of the year, has been reduced to £3 9s. 3d. In October a Government subsidy of £22,10s. 3d. was received, but this was more than counterbalanced by the quite unavoidable heavy expenditure. It is clear that the work of the Society will be seriously hampered unless more funds become available. In this connection the Council is pleased to be able to state that personal representations to the Premier, on the necessity for increased financial aid, have been received in a manner which makes it probable that a formal appeal, about to be made to the Treasury, will not go unanswered.

The number of members on the register is 118, of whom 107 are ordinary members, 4 junior members, and 7 honorary members. The number of those who have paid subscriptions for the year under review is 48. The Society has lost a prominent member by the death of Mr. J. B. Allen, whose educational work in mathematics and physics is well known. Six members retired in the course of the year, and 21 were elected.

In June, 1911, the Society received notice to quit the premises in the Agricultural Department, which had been occupied, rent free, for some time previously. After a considerable search for new quarters it was arranged to share the large room of the Theosophical Society, at the top of the "West Australian" Chambers, at a rental which was first fixed at 10s. a week and afterwards reduced to 30s. a month. The transfer of the Society's property took place on 31st July, 1911.

The Council has met 21 times during the year. From time to time it has been necessary to fill vacant places by the election of new members, one of whom, Mr. J. J. East, was chosen to be treasurer on the resignation of Mr. W. Catton Grasby. Of the ten members originally elected, only five remain.

Twelve General Meetings, besides the Annual Meeting, have been held, and at these the following papers were read:— "The Permo-Carboniferous Glacial Beds of Western Australia," being the presidential address of Mr. A. Gibb Maitland for the year 1910-11; "The Federal Capital Site," by Mr. J. G. Hay; "A Description of some Artificial and Reconstructed Gems," by Mr. I. H. Boas; "Unusual Types of Petrification from Dandarragan," by Mr. E. S. Simpson; "The Causes of the Fertility of the Semi-arid Wheat Lands of Western Australia," by Mr. G. A. Pfister; "A Triumph of Mendelism in Wheat Breeding," by Mr. W. Catton Grasby; "The Protozoic Rocks of the North of Western Australia," by Mr. L. Glauert; "Certain of the Properties and Functions of the Skin of the Potato Tuber," by Dr. F. Stoward; and, lastly, the presidential address of Mr. E. S.

Simpson for the year 1911-12, which took the form of a paper on "The Rare Metals and their Distribution in Western Australia." One evening was devoted to a discussion on the divining rod, opened by Mr. A. Gibb Maitland. The attendances generally were good, but the capacity of the Society's room was never overtaxed.

During the past twelve months excursions were made to Boya, the West Subiaco lime kilns, Swan View, and Gosnells. In May, Mr. W. E. Cooke provided an instructive evening at the Observatory, and demonstrated with the new 12½-inch reflector.

The second part of Vol. III of the "Journal," containing 115 pages, and an exhaustive index to the two parts by Mr. A. Gibb Maitland, was issued early in the present year. The cost of its production was exceptionally heavy.

Among presentations to the Society mention must be made of the late Mr. Alex. Purdie's valuable collection of botanical specimens, the gift of Mrs. Purdie.

Signs are not wanting of a quickening of interest in scientific matters in this State. The foundation of the Perth University, the recent scientific expeditions in the North-West, and the approaching construction of the trans-Australian railway, are events which cannot be without influence, direct or indirect, upon the fortunes of this Society. The Council is gratified at the progress made in the past, and looks with confidence to a period of increased activity in the immediate future.

(Signed)

EDWARD S. SIMPSON, *President*
MAURICE A. BROWNE, *Honorary Secretary*

STATEMENT OF RECEIPTS AND EXPENDITURE FOR YEAR ENDED JUNE 30, 1912.

RECEIPTS.

	£	s.	d.	£	s.	d.
To Balance in Bank from last year....				32	11	4
,, MEMBERS' SUBSCRIPTIONS						
Full Members						
For year 1911-12, 46 at 10s. 6d.	24	3	0			
Arrears, 1910-11, 1 at 10s. 6d.		10	6			
In advance for 1912-13, 2 at 10s. 6d., 1 at 4s. 6d.......	1	5	6			
Junior Members, 2 at 5s.		10	0			
				26	9	0
,, OTHER RECEIPTS						
Government Subsidy	22	10	3			
Sales of "Journals" and recoups for authors' copies	1	16	6			
Interest on Savings Bank A/c..		12	1			
Special Donations by Seven Members on Printing A/c ...	8	16	0			
				33	14	10
				£92	15	2

EXPENDITURE.

	£	s.	d.	£	s.	d.
By Printing and Stationery	56	6	0			
,, Rent of Meeting Room	17	8	0			
,, Special Audit Fees	5	5	0			
,, General Expenses	2	2	6			
,, Petty Cash Payments	8	0	11			
,, Bank Charges		3	6			
				89	5	11
,, Balance in Bank	15	19	3			
Less Outstanding Cheques	12	10	0			
				3	9	3
				£92	15	2

Audited and found correct.
(Signed) A. OCTAVIUS WATKINS,
ALEX. J. ROBERTSON, *Auditors.*

(Signed) J. J. EAST,
Hon. Treasurer.
1st July, 1912.

August 13th, 1912

Dr C G Thorp, President, in the Chair.

The list of donations to the Library was read.

The following specimens were exhibited :

A variety of cut and polished pieces of precious serpentine from Western Australia, by E. S. Simpson, B.E., F.C.S.

A number of plant specimens from Albany, including *Andersonia sp.*, *Banksia coccinea*, and a *Prasophyllum* not described in Bentham, by Frank Tratman, M.D.

Examples of *Dryandra*, by Miss Creeth.

September 3rd, 1912.

Dr. C. G. Thorp, President, in the Chair.

Mr. H. Rowley, F.C.S., Miss Rowley, Miss Jobson, Miss B. Cumpston, and Mr. K. Fairbridge, were elected members of the Society. Mr. R. Lapsley was elected a junior member. Mr. W. E. Cooke, M.A., F.R.A.S., was elected an honorary member.

Basil Cooke gave a demonstration of the working of wireless telegraphy with apparatus of his own construction.

October 8th, 1912

Dr. C. G. Thorp, President, in the Chair.

The list of donations to the Library was read.

The following communication was read :—" Two Methods of Weighing the Cornets, in the Assay of Gold Bullion," by A. O. Watkins, A.R.S.M., F.G.S.

Miss Creeth made a report of the excursion which had been held in King's Park on 21st September, and handed in a list of flowers found there.

The following specimen was exhibited :—

A hand specimen of the Boya Dyke, showing a narrower dyke cutting across it as a later intrusion, by E. S. Simpson, B.E., F.C.S.

November 11th, 1912.

Dr. C. G. Thorp, President, in the Chair.

The Rev. James MacDougall, Mr. F. W. Wakefield, and Mr. W. C. Thomas were elected members of the Society.

The list of donations to the Library was read.

The following communication was read :—

" Colour Photography," by Dr. C. G. Thorp.

The following specimens were exhibited :—

Large hermit crab, with cluster of eggs attached, occupying shell of a gasteropod. *Campanile laevis*, upon which shell numbers of *Amalthea australis* were parasitic ; also shell of young *Campanile laevis*, containing its original inhabitant ; also botanical specimens ; by E. S. Simpson, B.E., F.C.S.

December 10th, 1912.

Mr. J. J. East, Treasurer, in the Chair.

Miss Jean Bird and Mr. R. W. Canning, A.C.G.I., were elected members of the Society.

The list of donations to the Library was read.

H. B. Curlewis, B.A., described in outline the work which the new Astronomical Society proposed to carry out, and recounted the reasons which had led to its formation.

January 14th, 1913.

Mr. E. S. Simposn, B.E., F.C.S., Vice-President, in the Chair.

Mr Alex Montgomery, Mrs. Alex. Montgomery, Mr. Evelyn Manning, and Mr. H. B. Curlewis, B.A., were elected members of the Society.

The list of donations to the Library was read.

February 11th, 1913.

Mr. E. S. Simpson, B.E., F.C.S., Vice-President, in the Chair.

Dr. Alex. Morrison was elected an honorary member of the Society.

The list of donations to the Library was read.

The following communication was read :—

" Modern Investigations of Problems Connected with Sea Fisheries," by W. B. Alexander, B.A.

The following specimens were exhibited :—

An Australian rockling from Busselton, and a specimen of the rare oar fish, from Rottnest, by W. B. Alexander, B.A.

Fossil leaves* from Kojonup, by Mrs. Shelton.

Gasteropod shells from Norseman and Dundas, by W. D. Campbell, F.G.S.

Emeralds recently discovered near Kew, by E. S. Simpson, B.E., F.C.S.

March 11th, 1913.

Mr. E. S. Simpson, B.E., F.C.S., Vice-President, in the Chair.

Professor W. G. Woolnough, D.Sc., was elected a member of the Society.

The list of donations to the Library was read.

Notice of the following motion for the ensuing meeting was made by A. Gibb Maitland, F.G.S. :—

" That the time has arrived for obtaining a Royal Charter for the Society, and, if granted, altering its designation to the

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*These were handed over to the Government Geologist, and a description of them appears in the Annual Progress Report of the Geological Survey for 1913.

Royal Society of Western Australia, and the necessary steps towards that end should immediately be taken."

The following communications from W. D. Campbell, A.K.C., F.G.S., A.M.I.C.E., L.S., were read by A. Gibb Maitland F.G.S. :

1. "A Description of a Rock Shelter with Aboriginal Markings and an Indurated Cast of a Footprint at the Greenough River, and a Cave Dwelling at Narandagy Spring, Lockier River."

2. "A Description of a Cave with Aboriginal Markings at Apertarra, and of a Cave and Rock Shelters at Willow Gully, Nonja and Norman Well, Northampton."

The following specimen was exhibited :

Wolfram from Brookton, by Mrs. Shelton.

April 8th, 1913.

Mr. J. J. East, Treasurer, in the Chair.

Professor N. T. M. Wilsmore, D.Sc., Professor A. D. Ross, M.A., D.Sc., F.R.A.S., F.R.S.E., and Professor H. E. Whitfeld, B.A., B.E., were elected members of the Society.

The list of donations to the Library was read.

The following exhibits were made :

A large variety of ferns from the neighbourhoods of Hobart, Launceston, and Russell Falls, by A. J. Hall.

A contour map of Western Australia, in course of execution from hitherto unused data, by J J East.

May 13th, 1913

Mr. A. Gibb Maitland, F.G.S., Vice-President, in the Chair.

Professor W. J. Dakin, D.Sc., Mr. I. A. Ridgway, M.Sc., Mrs. W. J. Hancock, Mrs. A. J. Robertson, and Mr. W. G. Bell, B.Sc., were elected members of the Society.

The list of donations to the Library was read.

The following motion was made by A. Gibb Mailtand, F.G.S., and seconded by W. Catton Grasby, F.L.S. :

"That the time has arrived for taking the necessary steps for altering the designation to 'The Royal Society of Western Australia,' and for obtaining the Royal Assent thereto ; and that the matter be left in the hands of the Council." Carried.

The following communication was read :

"The Potato Moth : An Experimental Investigation into the Methods of Controlling its Ravages in Stored Tubers," by F. Stoward, D.Sc. (Birm.).

June 10th, 1913.

Mr. A. Gibb Maitland, F.G.S., Vice-President, in the Chair.

Miss Frances Butters was elected a member of the Society.

The list of donations to the Library was read.

The following communication was read :—

"The Cretaceous Fossils of the Gin-Gin Chalk and their Geological Relationships," by A. Gibb Maitland, F.G.S.

July 11th, 1913.

Dr. C. G. Thorp, President, in the Chair.

The list of donations to the Library was read. Included among them were 14 books, besides a number of "Journals" of the Mueller Botanic Society, the W.A. Natural History Society, and the Natural History and Science Society of W.A., the gift of Dr. Tratman.

The anniversary address, by Dr. C. G. Thorp, M.B., C.M., entitled "A Contribution to the Study of Australites," was read.

ANNUAL GENERAL MEETING.

July 15th, 1913.

Dr. C. G. Thorp, President, in the Chair.

The following were elected office-bearers for the ensuing year :

President : Professor W. J. Dakin, D.Sc. F.L.S., F.Z.S.
Vice-Presidents : Mr. A. Gibb Maitland, F.G.S. ; Mr. E. S. Simpson, B.E., F.C.S.
Hon. Secretary : Mr. Maurice A. Browne, B.A.
Hon. Treasurer : Mr. J. J. East.
Members of Council : Mr. W. J. Hancock, M.Inst. C.E., M.I.E.E. ; Professor A. D Ross, M.A., D.Sc., F.R.A.S., F.R.S.E. ; Professor W. G. Woolnough, D.Sc. ; Mr. Bernard H. Woodward, F.G.S., C.M.Z.S.; Mr. H. B. Curlewis, B.A.
Auditors : Mr. A. J. Robertson, M.Sc. ; Dr. F. Stoward, D.Sc.

REPORT OF THE COUNCIL FOR THE YEAR 1912-13.

Ladies and Gentlemen,

Your Council has much pleasure in submitting the Annual Report and Financial Statement for the year ended 30th June, 1913.

Notwithstanding a grant of £25 which was obtained from the Government on 1st July, 1912, the Society's credit balance, which stood at £3 9s. 3d. at the beginning of the financial year, is now £5 6s. 1d. Against this there is the balance of an outstanding account of £31 11s. 11d. due to Messrs. V. K. Jones and Co., in respect of the printing of the "Journal."

The number of members on the register is 114, of whom 101 are ordinary members, 4 junior members, and 9 honorary members. Two prominent members, Mr. W. E. Cooke and Dr. Alex. Morrison, who have accepted positions in the Eastern States, have been placed upon the honorary list, in recognition of their services to astronomy and botany respectively and to the Society. In addition to these, 1 member resigned from the Society and 30 were removed for being two years in arrears, under By-law 4, while 27 new members, including the five scientific Professors of the University, were elected.

The Council has met 15 times during the year. At the first meeting of the new Council Mr. Maitland and Dr. Tratman were re-elected editors of the "Journal," and Mr. A. O. Watkins was elected librarian. The president, Dr. C. G. Thorp, was absent in Derby for about six months. Dr. Morrison left us in January, and Mr. A. Gibb Maitland was subsequently elected vice-president in his place.

Eleven General Meetings, besides the Annual Meeting, were held, and at these the following papers were read :—" Two Methods of Weighing the Cornets, in the Assay of Gold Bullion, by which the Balance Readings give the Finenesses Directly, *i.e.*, the Weights of Cornets Corrected for Surcharge ; with Incidental Improvements in the Assay," by Mr. A. O. Watkins ; " Colour Photography," by Dr. C. G. Thorp ; " Modern Investigations of Problems connected with Sea Fisheries," by Mr. W. B. Alexander ; two papers on Rock Shelters and Aboriginal Markings, by Mr. W. D. Campbell, read by Mr. Maitland ; " The Insensitivity of Various Life Forms of the Potato Moth to Certain Poisons," by Dr. F. Stoward ; and " The Cretaceous Fossils of the Gin-Gin Chalk and their Geological Relationships," by Mr. A. Gibb Maitland. At the September meeting Mr. Basil Cooke gave a demonstration of his wireless telegraphy apparatus at the Observatory, and in December Mr. H. B. Curlewis described in outline the work which the newly formed Astronomical Society proposed to undertake.

During the past twelve months excursions were made to Darlington and Boya, to King's Park (twice), to Kelmscott, to the Applecross wireless station by motor launch, and to a point beyond Guildford by the same means, and to Gooseberry Hill.

Volume IV of the Society's " Journal " was published in February of this year at a cost of £56 11s. 11d.

Presentations to the Society include a score of scientific books and a number of volumes of the " Journal of the Department of Agriculture of Western Austarlia," by Dr. C. G. Thorp, and an old edition of Cuvier's " Comparative Anatomy," in six volumes by Dr. Frank Tratman Forty-one societies and institutions are now upon the exchange list.

At the instance of the Western Australian Institution of Engineers, this Society has arranged to confer with other scientific and technical societies of Perth on a proposal to approach the Government with a request for a grant of land on which to erect a building for their joint accommodation.

By a resolution of the General Meeting of 13th May the Council was requested to take the necessary steps to obtain the assent of the Sovereign to the assumption by the Society of the title of " The Royal Society of Western Australia." To this end, a memorial, accompanied by a bound volume of the last three numbers of the Society's " Journal," has been forwarded through the Governor, Sir Harry Barron, to His Majesty the King, praying him to permit the use of the new name, and to become Patron of the Society. If this request is granted, the Society will come into line with the Royal Societies of the other States of the Commonwealth, and alterations in the Rules and By-laws, especially as regards the conditions of membership, will become necessary

(Signed)

C. G. THORP, *President.*
MAURICE A. BROWNE, *Honorary Secretary.*

STATEMENT OF RECEIPTS AND EXPENDITURE FOR YEAR ENDED JUNE 30, 1913.

RECEIPTS.

	£	s.	d.	£	s.	d.
To Balance in Bank from last year ...				3	9	3
,, MEMBERS' SUBSCRIPTIONS						
61 Full Members for year 1912-13 at 10s. 6d.	32	0	6			
Arrears paid (6 at 10s. 6d.)....	3	3	0			
In advance for 1913-14........	1	13	0			
2 Junior Members at 5s.		10	0			
				37	6	6
,, OTHER RECEIPTS						
Government Grant	25	0	0			
Sales of "Journal" and authors' extra copies of papers.......	3	18	10			
Savings Bank Interest on A/c..		9	0			
				29	7	10
				£70	3	7

EXPENDITURE.

	£	s.	d.	£	s.	d.
By Printing and Stationery	31	17	9			
,, Binding Royal Presentation Volumes (2)....................		16	0			
,, Rent	18	0	0			
,, General Expenses	1	5	0			
,, Petty Cash payments	12	17	9			
,, Bank Charges		1	0			
				64	17	6
,, Balance in Bank				5	6	1
				£70	3	7

Audited and found correct, 9/7/13.
(Signed) F. STOWARD,
ALEX. J. ROBERTSON, *Auditors.*

(Signed) J. J. EAST,
Hon. Treasurer.

August 12th, 1913.

Professor W. J. Dakin, D.Sc., President, in the Chair.

Mr. J. B. Storey was elected a member of the Society.

The list of donations to the Library was read.

The following communication was read :—

" The Onychophora of Western Australia," by W. J. Dakin, D.Sc.

Exhibits were made by W. B. Alexander, M.A., with the following explanations : —

The first consisted of specimens of the three local species of Freshwater Crayfish, viz. : the Marron, *Chaeraps tenuimanus*, Smith ; the Gilgie, *C. quinquecarinatus*, Gray ; and the Coonac, *C. preissii*, Erich. It was mentioned that four names of Crayfish (or Crawfish) were given in G. F. Moore's " Vocabulary of the Language of W.A.," and of these Tjilki and Dill (Vasse) and Konak (King George's Sound) were evidently the originals of Gilgie and Coonac, whilst the fourth name, Yarril (King George's Sound), may have been corrupted into Marron. The only other known species of the W.A. genus Chaeraps was *C. quadricarinatus*, which occurs in New Guinea, the Aru Islands, and Cape York. The great gap in the distribution of the genus might be due to insufficient knowledge of the intervening region, or to the comparatively arid nature of the country. In S.E. Australia and Tasmania the crayfishes belonged to another genus, Astacopsis. As far as was known at that time the Marron was found in all the rivers from the Harvey south to Denmark ; the Gilgie in streams tributary to the Swan and other rivers as far south as the Vasse ; whilst the Coonac had been obtained in ponds and small streams from Harvey to the Margaret River. Enquiries which were still being prosecuted would probably lead to an increased habitat for several of the species.

The second exhibit was a Brachiopod, *Terebratulina radiata*, found on the beach at Cottesloe by the speaker in July This was only the second species of Brachiopod recorded for the State, the other being *T. cancellata*, of which species the type specimens were said to come from Western Australia. *T. radiata* had previously been found in South Africa. Specimens of the common East Australian form, *Magellania flavescens*, were also exhibited, showing the internal structure, and it was pointed out that the resemblance between Brachiopods and Molluscs was only superficial.

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September 9th, 1913.

Professor W. J. Dakin, D.Sc., President, in the Chair.

Mr. V. S. Rawson was elected a member of the Society

The list of donations to the Library (including Nos 4, 6 and 7 of the " Journal " of the Mueller Botanic Society, by Miss Creeth) was read.

The following communications were read or placed before the meeting :—

1 "Aquatic Animals from Hannan's Lake, Kalgoorlie" by W. B. Alexander, M.A.

2 "The History of Zoology in Western Australia Part I, –Discoveries in the 17th Century." by W. B. Alexander, M.A.

3 "Third Abstract of the Reports of the German Expedition of 1905 to South-Western Australia," by Prof. Dr. W. Michaelsen. Communicated by Bernard H. Woodward, C.M.Z.S., F.G.S.

October 14th 1913.

Professor W. J. Dakin D.Sc. President in the Chair.

The list of donations to the Library was read.

The following communication was read :—

"The Foundation Stones of Western Australia : An Early Chapter in the Geological History of the State" by A. Gibb Maitland F.G.S.

November 11th 1913.

Mr. E. S. Simpson B.E. F.C.S. Vice-President in the Chair.

Mr. I. H. Boas B.Sc. and Mr. A. Male M.L.A., were elected members of the Society.

The list of donations to the Library was read.

The following communication was read :—

"Time and Its Measurement," by A. D. Ross, M.A., D.Sc. F.R.A.S., F.R.S.E.

December 9th, 1913.

Professor W. J. Dakin, D.Sc., President, in the Chair.

Mr. J. A. Wood was elected a member of the Society.

The list of donations to the Library was read.

The President announced that he had received from His Excellency the Governor a communication to the effect that His Majesty the King had graciously assented to the assumption by the Society of the title, "The Royal Society of Western Australia." In making this announcement the President reviewed the previous history of the Society, from its inception, in 1891, and indicated the lines on which he considered the Royal Society should proceed.

Sir J. Winthrop Hackett offered his congratulations to the Society and its President on the well-deserved honour shown to them by His Majesty.

The following communications were read or placed before the meeting :—

1. "A Theory of the Method of Formation of Australites," by C. G. Thorp, M.B., C.M.

2. "The History of Zoology in Western Australia—Discoveries in the 17th Century. Additions" by W. B. Alexander, M.A.

The following specimens were exhibited :

A nudibranch, commensal hermit crab and anemones, an ascidian and a sea cucumber ; prepared in the Naples Marine Biological Institute ; shown by W. J. Dakin, D.Sc.

It was moved by W. B. Alexander, M.A., and seconded by W. J. Hancock, M.Inst.C.E., M.I.E.E., "that the President (Professor Dakin) with Professor Woolnough and Mr. Maitland, form a sub-committee to revise the Rules of the Society, in preparation for the change of title to 'The Royal Society of Western Australia.'" Carried.

It was resolved that the Society should go into recess during January and February.

March 10th, 1914.

Professor W. J. Dakin, D.Sc., President, in the Chair.

The list of donations to the Library was read.

The Rules for the Royal Society, as drafted by a sub-committee consisting of W. J. Dakin, D.Sc., W. G. Woolnough, D.Sc., and A. Gibb Maitland, F.G.S., and revised by the Council, were considered, amended and passed *seriatim*. The President moved and W. J. Hancock, M.Inst.C.E., M.I.E.E., seconded that the Rules as amended be adopted. Carried.

It was moved by Maurice A. Browne, B.A., and seconded by J. J. East, "That this Society be henceforth called 'The Royal Society of Western Australia,' and that its management be vested in the present Council until the election of the new Council in July." Carried.

Resolutions providing for the transfer of membership, the immediate election of new members, and the continuity of the Society's finances were carried, and ordered to be embodied in the Rules.

GENERAL INDEX

TO

THE JOURNAL AND PROCEEDINGS

OF

THE NATURAL HISTORY AND SCIENCE SOCIETY.

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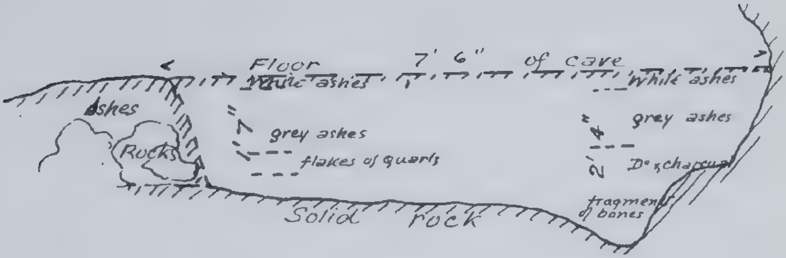

Fig. 1.

Section along trench.

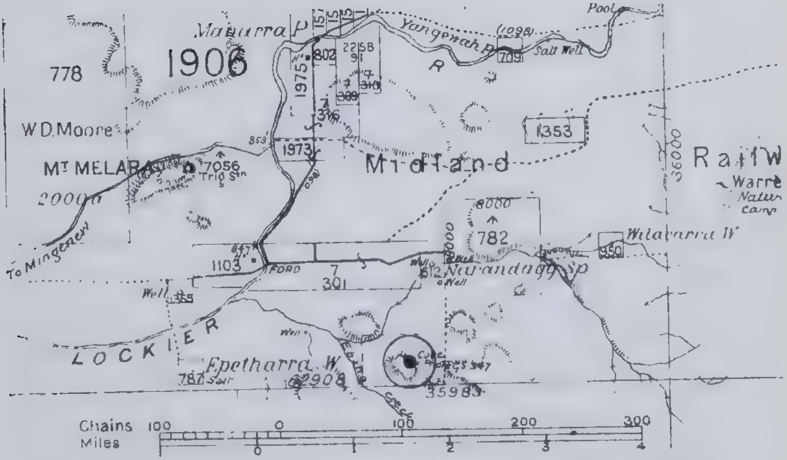

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Fig. 2.

Map showing Site of Cave Dwelling at Narandagy Spring.

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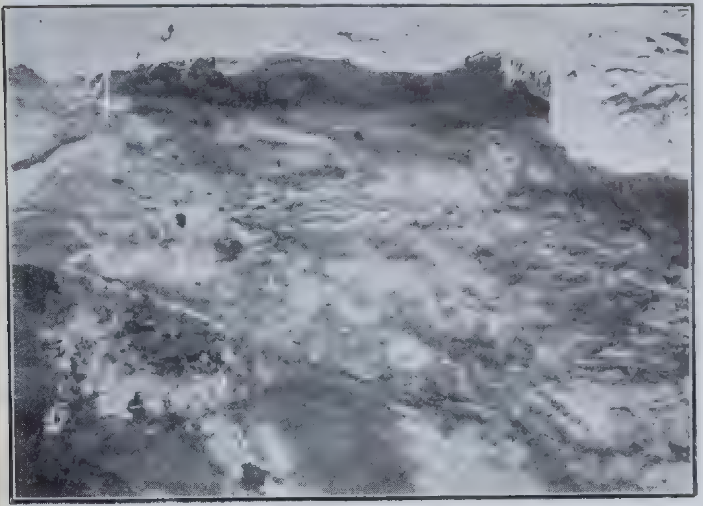

Fig. 4.

View of Interior, with Paintings, from the front

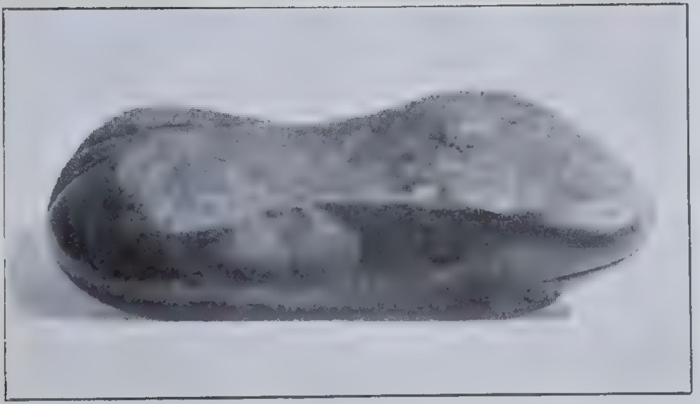

Fig. 5.

Cast of Aboriginal's Footprint, in Ferruginous Sandstone.

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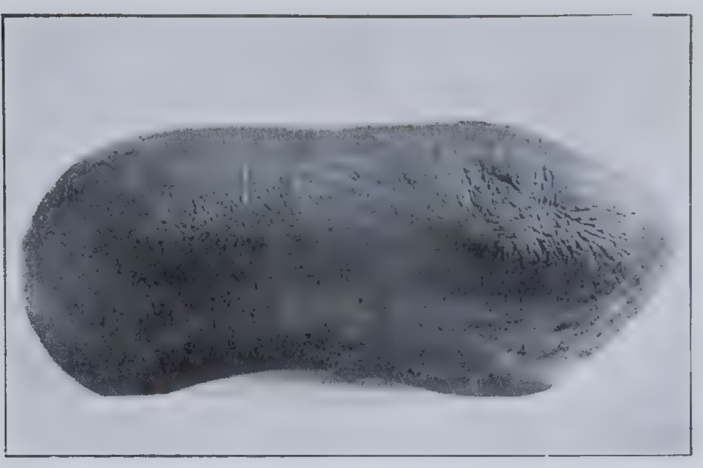

Fig 6.

View of Upper Surface of Cast.

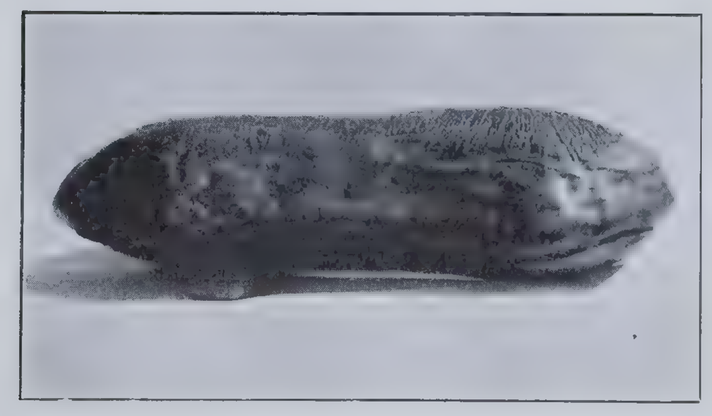

Fig. 7.

Side View of Cast.

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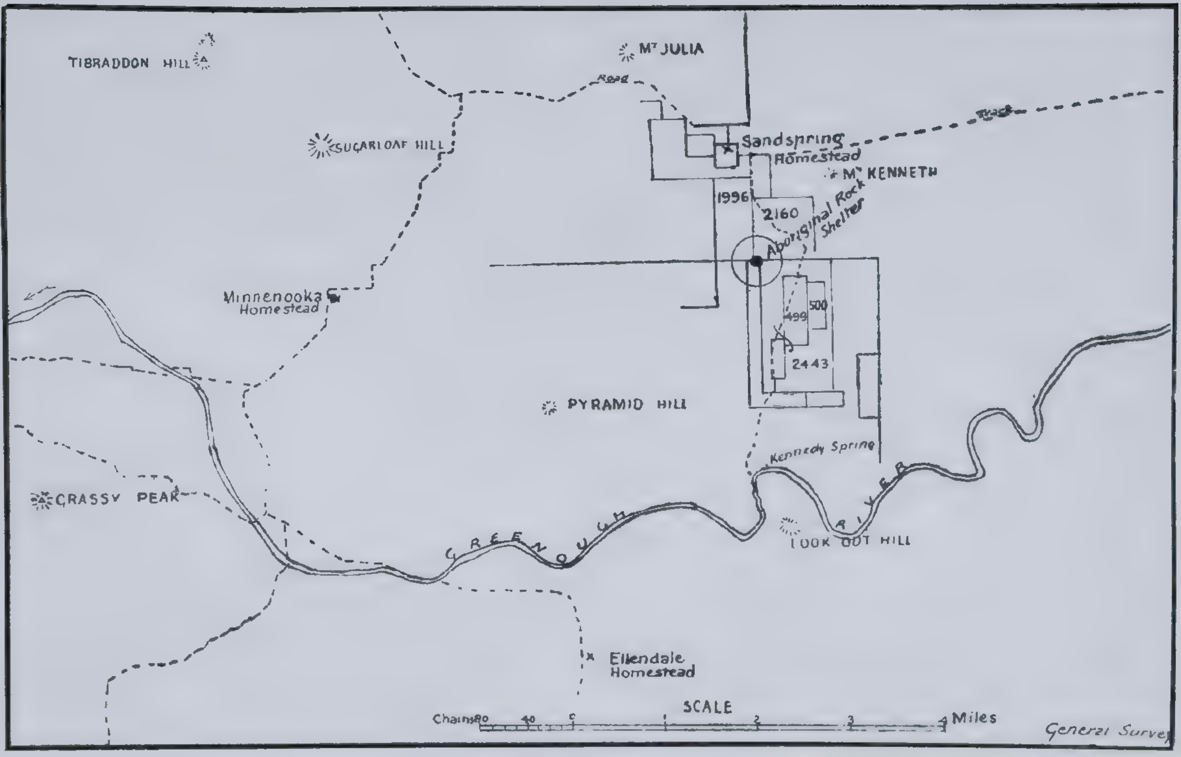

Map showing Site of Aboriginal Rockshelter, Greenough River.

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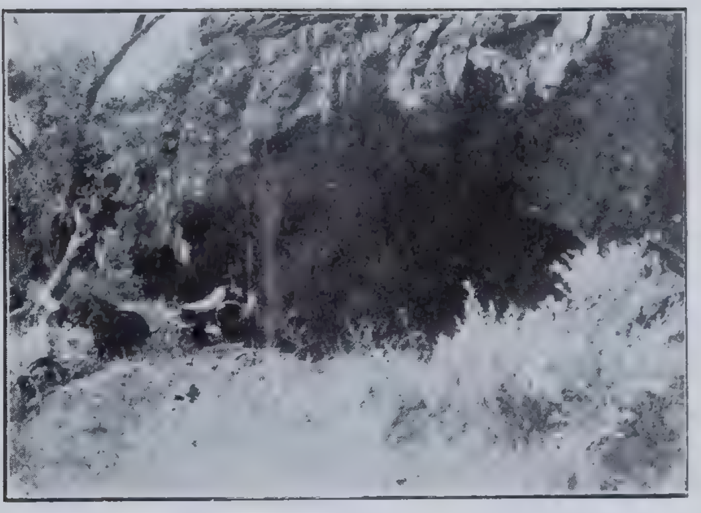

Fig. 8.

Cave one Mile South of Narandagy Spring, Lockier Valley.

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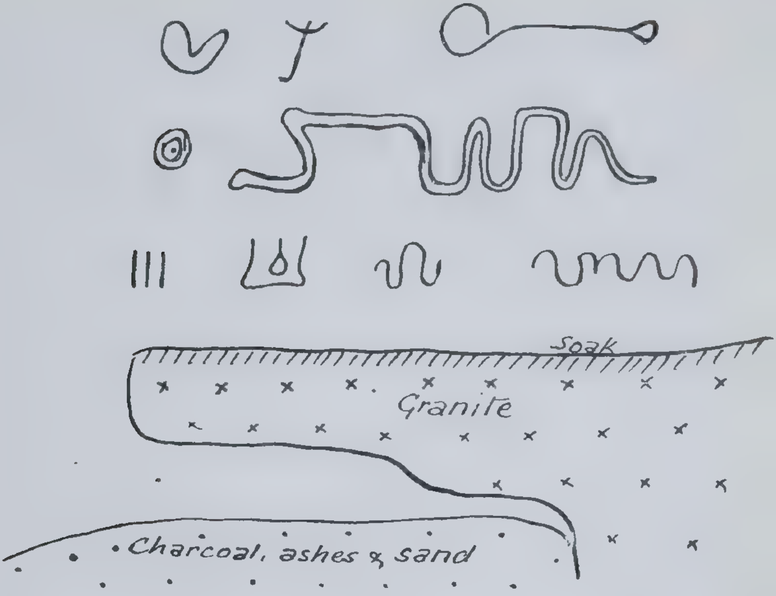

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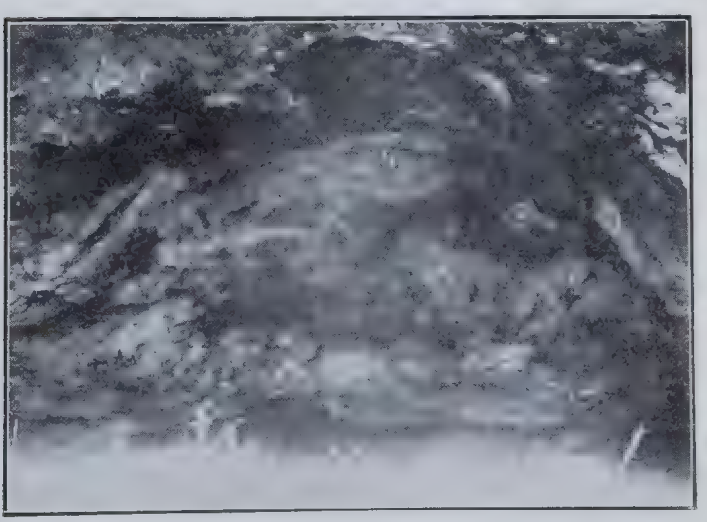

Fig. 2.

Cave at Appertarra, Northampton.

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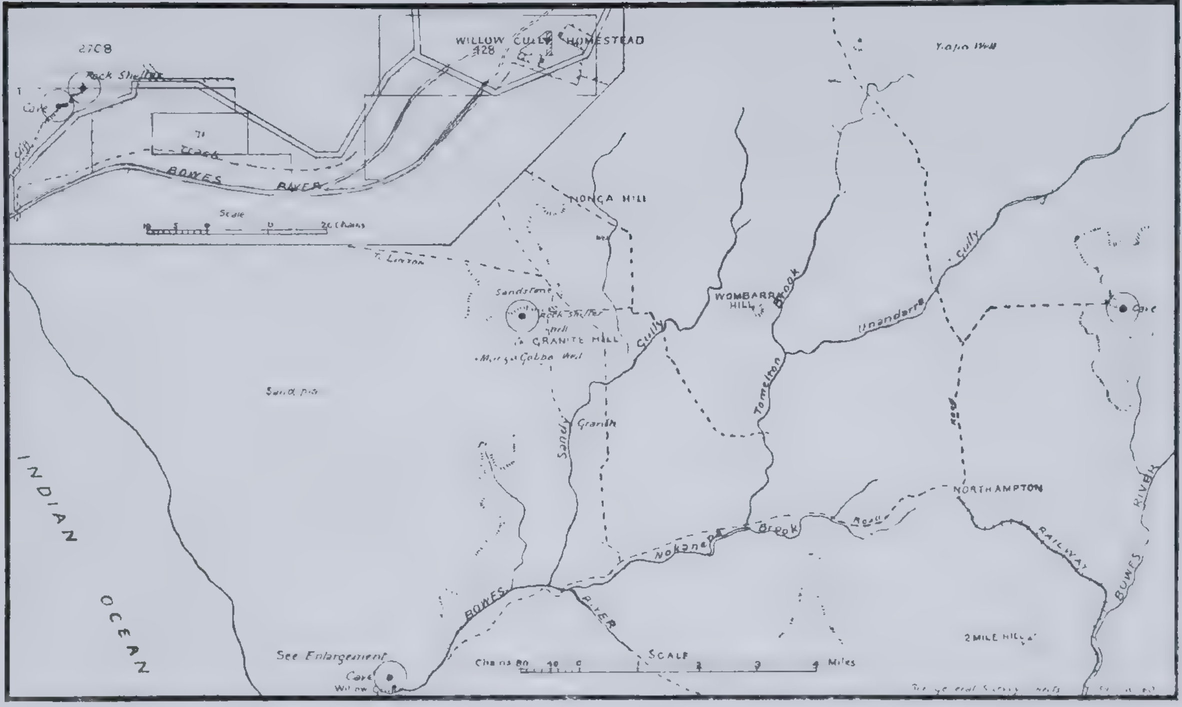

Maps showing Sites of Rockshelters and Caves near Northampton.

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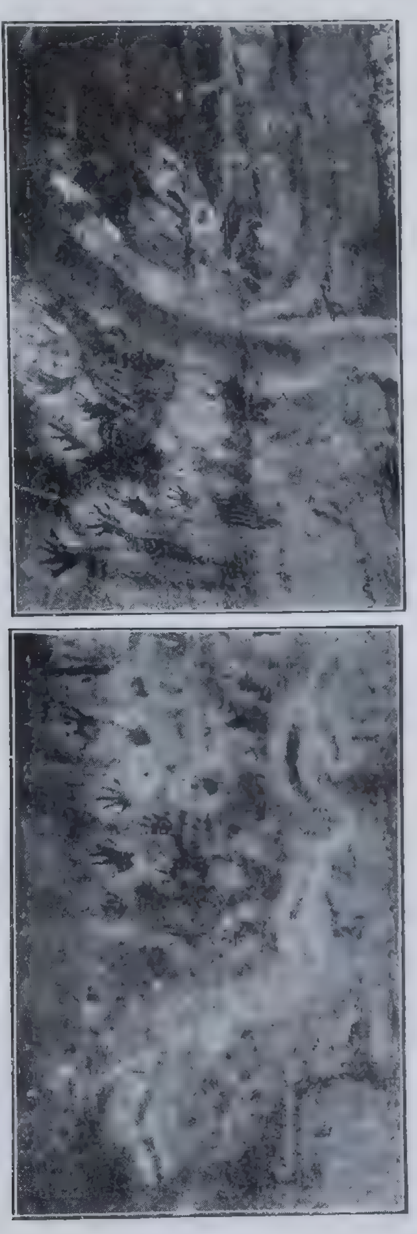

Fig. 3.
Rock Shelter at Willow Gully.

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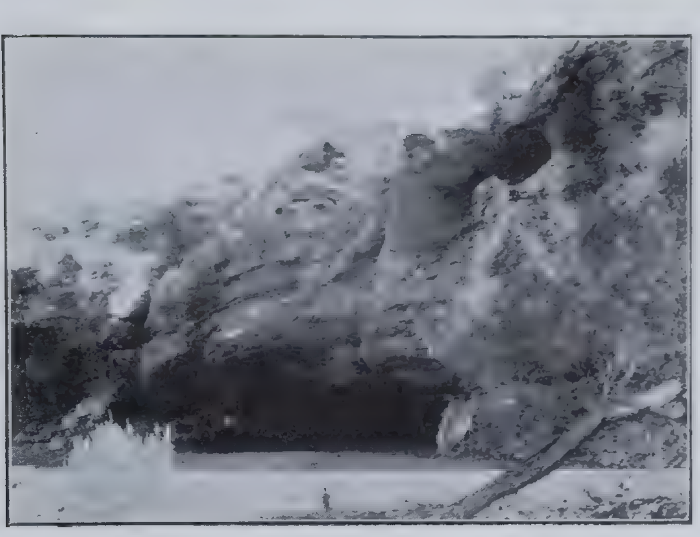

Fig. 4.

Cave at Willow Gully.

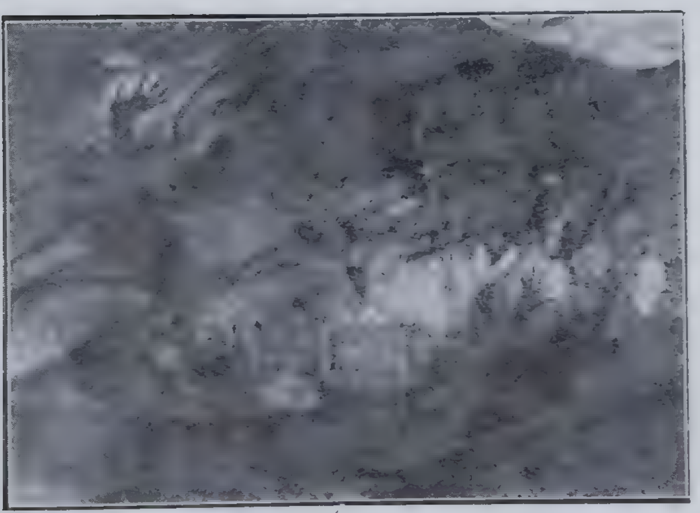

Fig. 5.

Cave at Willow Gully.

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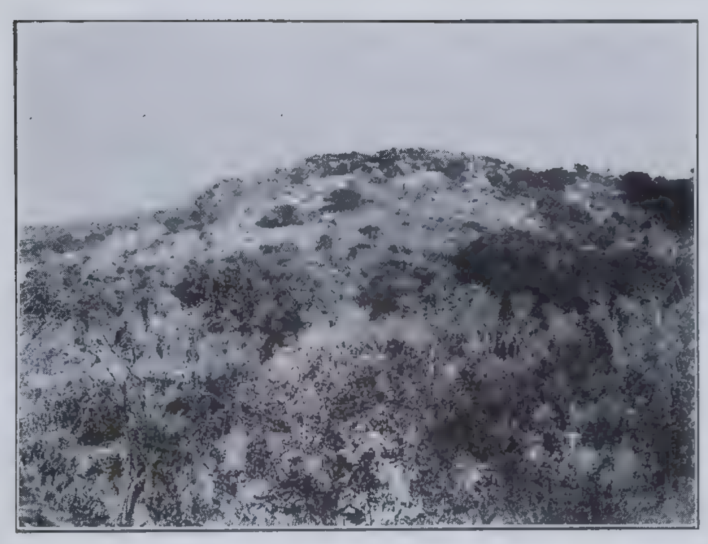

Fig. 6.

Rock Shelter near top of hill, Nonga.

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Photo: W. D. Campbell and J. A. Olsen.

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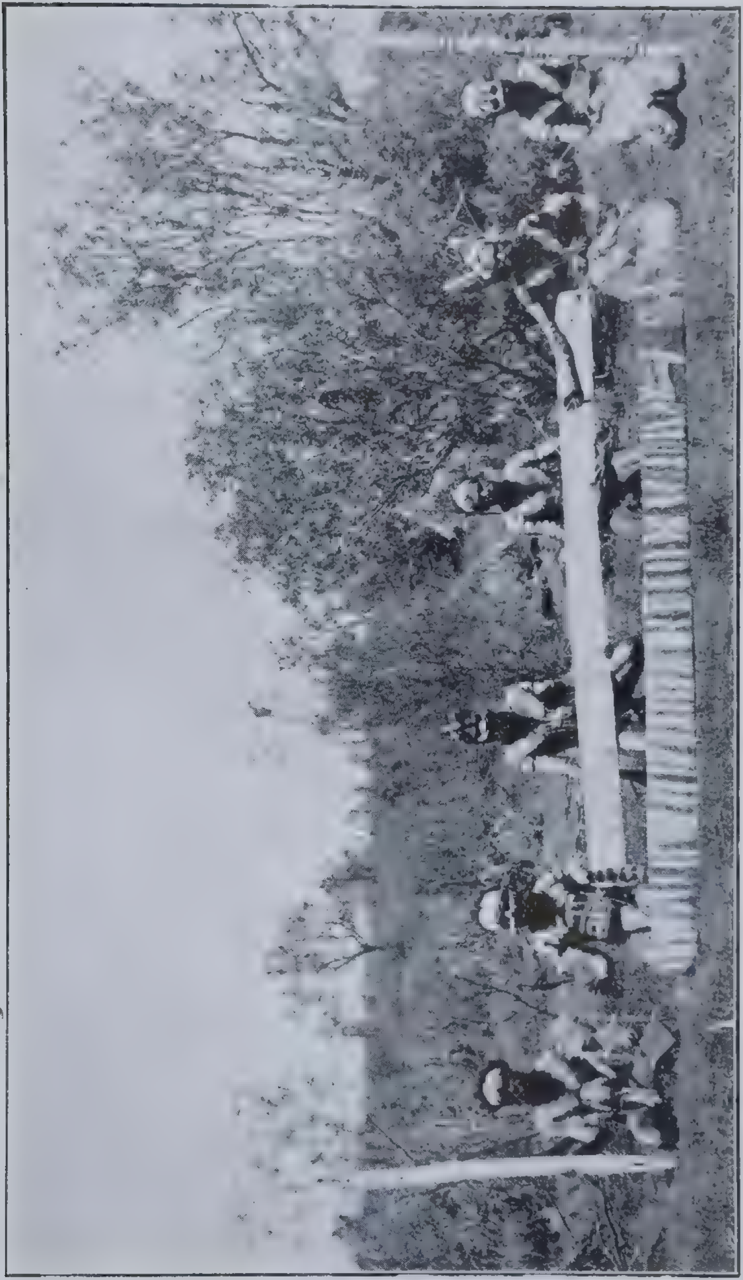

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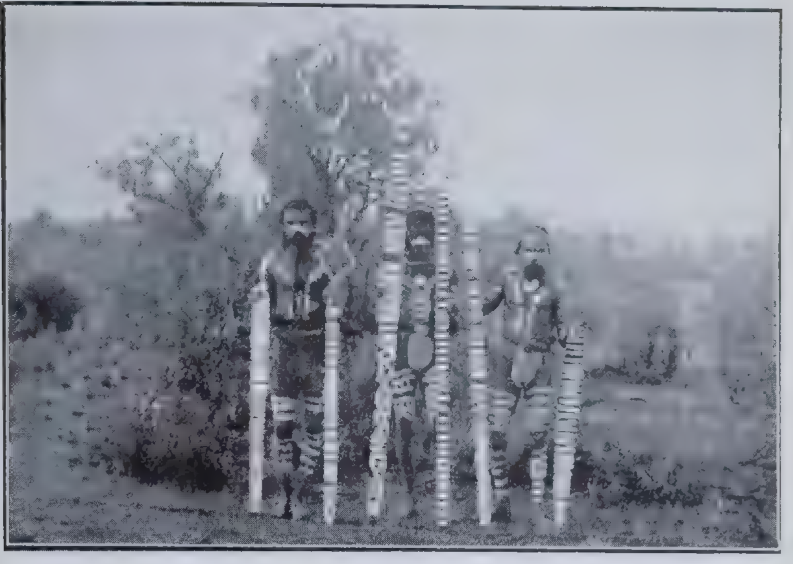

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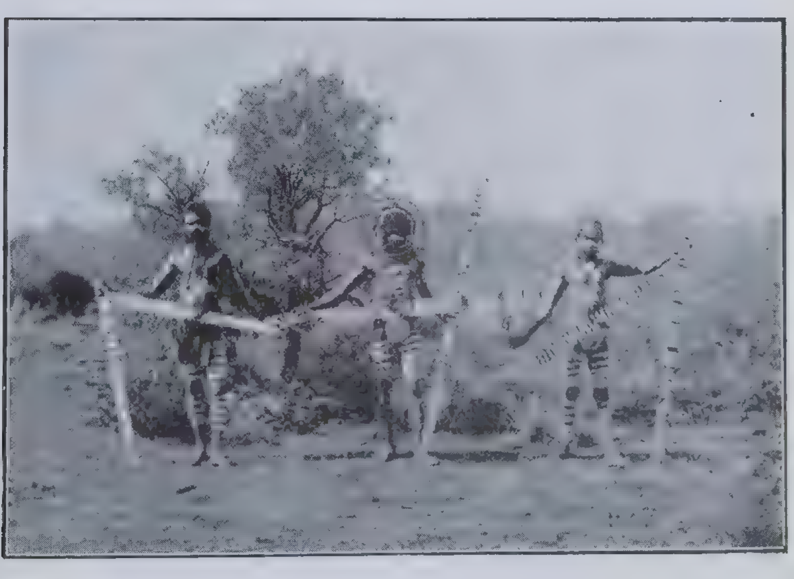

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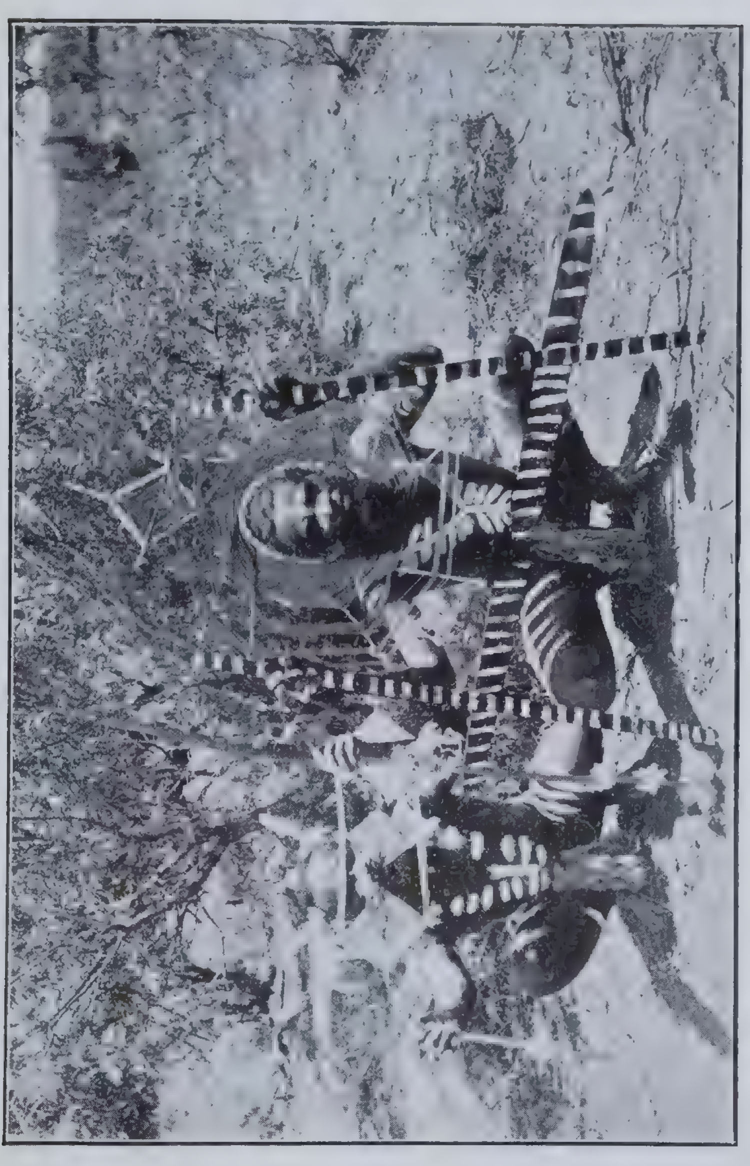

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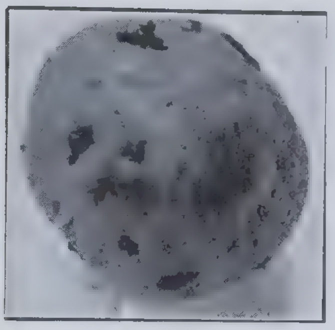

Fig. 1. Early Stage of Infestation.

The invading larvæ have entered the eyes of the tuber. The jet black masses are composed of the excrement of the infesting larvæ.

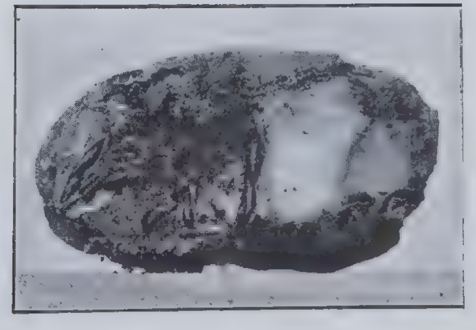

Fig. 2.—Advanced Stage of Infestation.

The infested tuber has mummified; the objects in the cavities are the pupæ of the moth.

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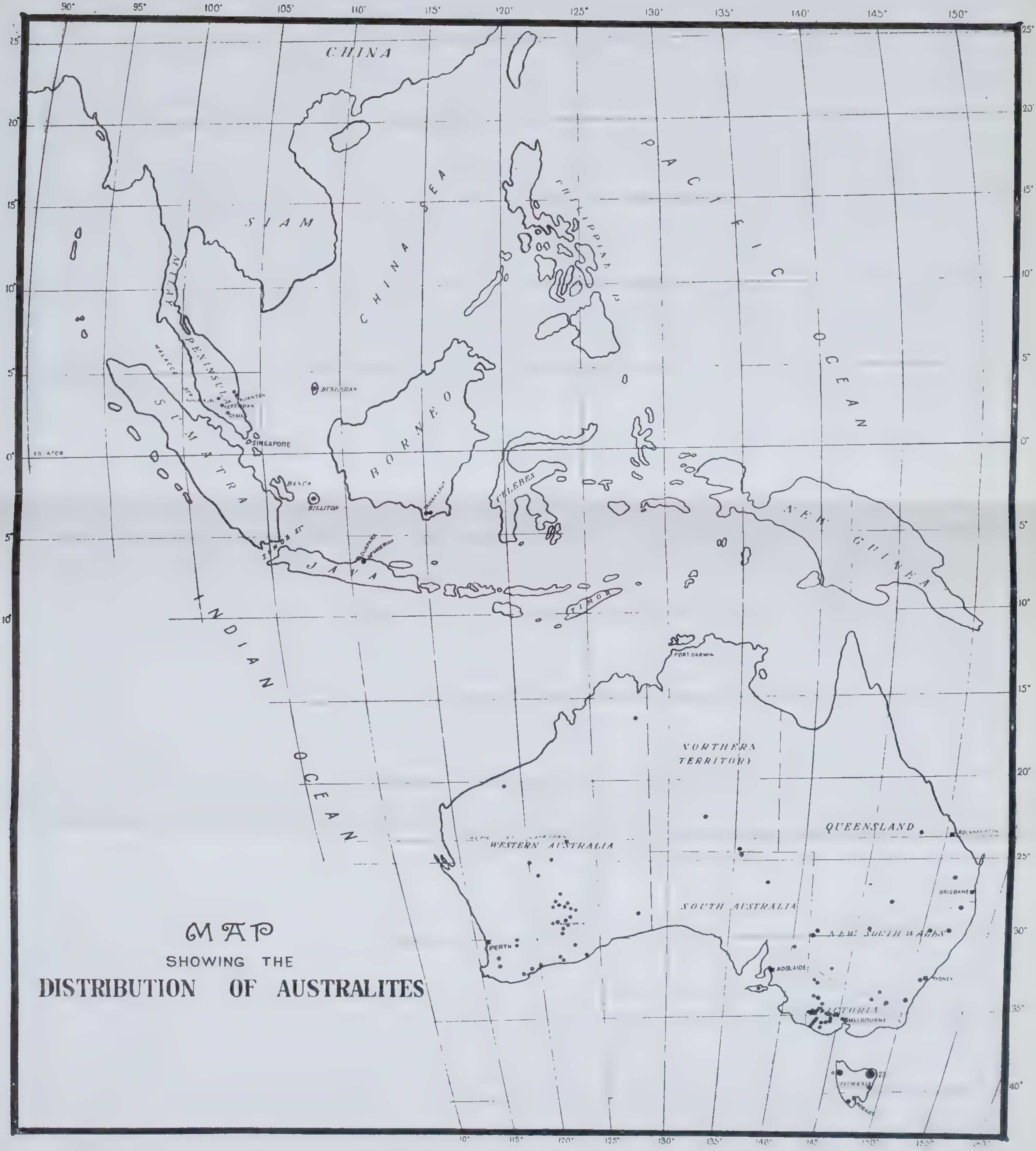

MAP
SHOWING THE
DISTRIBUTION OF AUSTRALITES

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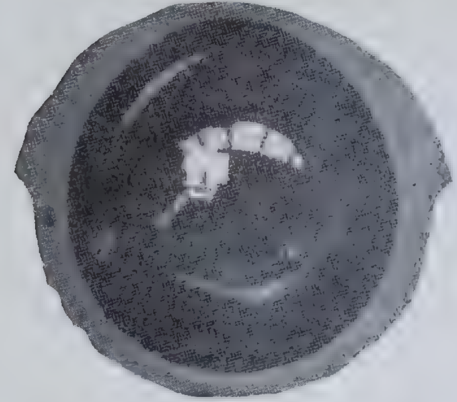
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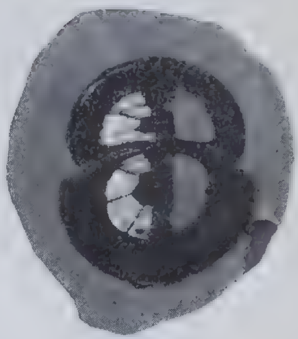
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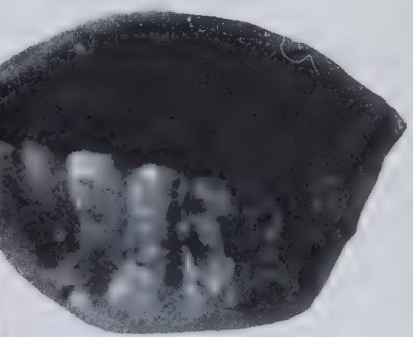
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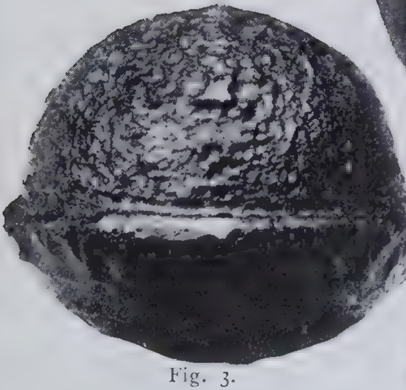
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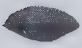
Fig. 5.

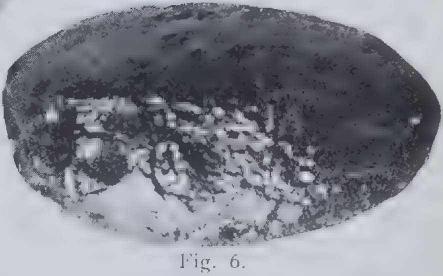
Fig. 6.

Fig. 1.—Section of Hollow Australite, normal Button Core Shape, showing the beautifully glazed interior.
Fig. 2.—Section of hollow Australite, deformed, glazed Cavity divided by Septum.
Fig. 3.—Core of Button from Kangaroo Island, figured by Suess.
Fig 4 —Normal Western Australian Conical Shape, enlarged for comparison with Fig. 3
Fig. 5.—Smallest Australite, Lens Shaped, from Coolgardie. Weight 4.9 grains.
Fig. 6.—Largest Australite, found by Sir John Forrest in Lat. 25-30 S., Long. 123 E. Weight 1,790.5 grains.

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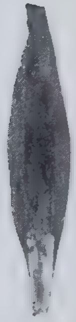

Fig. 2.

At the time of going to press, no drawing had been supplied by the Author.

Fig. 1.

Fig 1.—Section of button shaped Australite, showing the Core to be almost homogeneous, with much disturbance from the downward flow of the excess of glass forming the ring and exhibiting well the chin "d" restrained by the surface film on the inner side from flowing on to and coalescing with the Core.

Fig. 2.—Bleb or glass bubble showing Convex Surfaces both inside and outside the Bubble.

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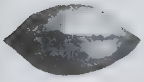
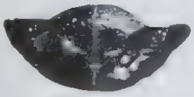


Fig. 1.

Fig. 2.

Fig. 3.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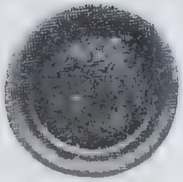
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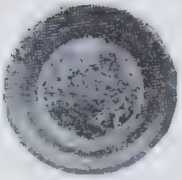
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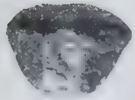
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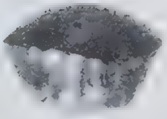
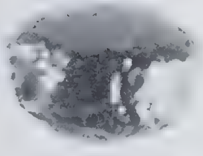


Fig. 11.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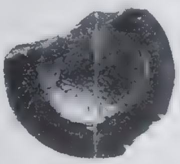


Fig. 5.

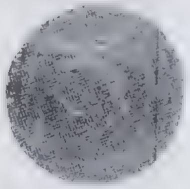
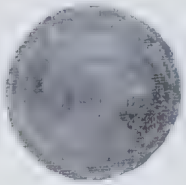


Fig. 8.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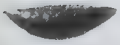
Fig. 13.

Fig. 14.

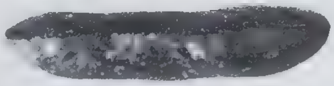
Fig. 15.

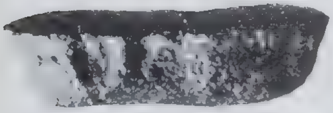
Fig. 16.

Fig. 17.

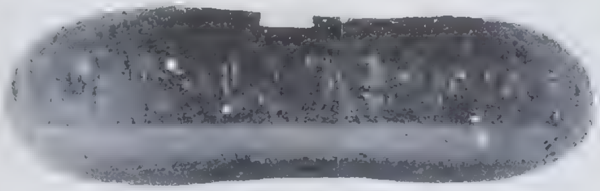
Fig. 18.

Fig. 1.—Normal Lens Shape, with sharp circumferential Ring.

Fig. 2.—Lens showing Line of Fracture of Ring on upper side of the ring.

Fig. 3.—Lens showing a portion of Ring attached, and other portions of the Ring, both showing Line of Fracture and complete, as in Fig. 1.

Fig. 4.—Button form from South Australia showing the Conical Shape of the Core.

Fig. 5.—Button form from South Australia showing the Conical Shape of the Core.

Fig. 6.
Fig. 7.
Fig. 8 } Upper and lower Surfaces of Buttons after W. Dunn.
Fig. 9.

Fig. 10.—Exaggerated Conical Shape showing long Fracture Facets.

Fig. 11.—Normal Conical Shape showing long Fracture Facets.

Fig. 12.—Highly glazed Conical Shape showing little trace of Fracture Facets, probably caused by the bubble bursting high in the atmosphere and the consequent air friction causing excessive fusion of the surface.

Fig. 13 —Oval Lens Shape showing sharp Longitudinal Curve.

Fig. 14.—Lens Dumb-bell showing Longitudinal Curve.

Fig. 15.—Flat Conical Dumb bell showing Longitudinal Curve.

Fig. 16.—Deep Conical Dumb-bell showing long Fracture Facets and Longitudinal Curve.

Fig. 17.—Dumb-bell that has evidently been in a fire and exhibits the chipping of the surface caused by sudden heating.

Fig. 18.—Large Dumb bell showing very slight Longitudinal Curve.

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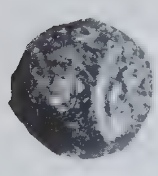


Fig. 1.

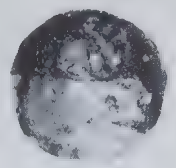
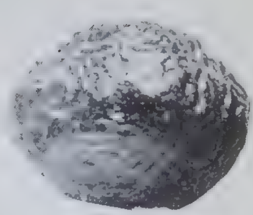


Fig. 2



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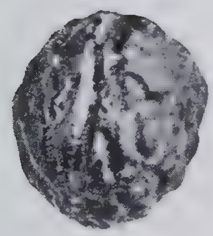

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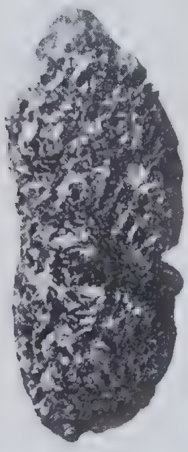

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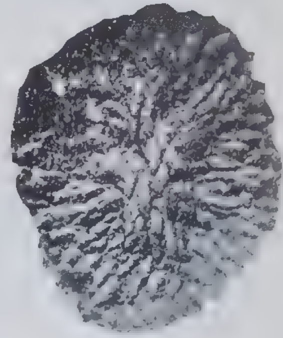

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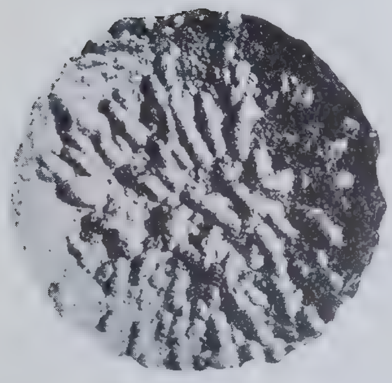

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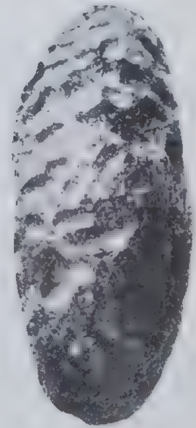

Fig. 8.

Figs. 1, 2, 3, 4.—Billitonites.

Figs. 5, 6.—Irregular Moldavites.

Figs. 7, 8.—Different aspects of one Moldavite, showing tendency to regularity of form.

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Fig. 1.

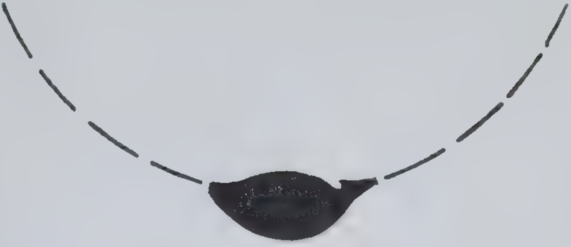


Fig. 2.

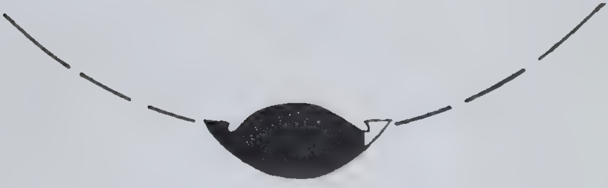


Fig. 3.

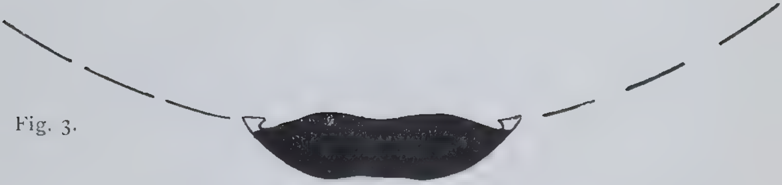
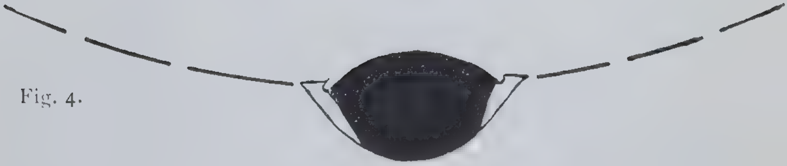
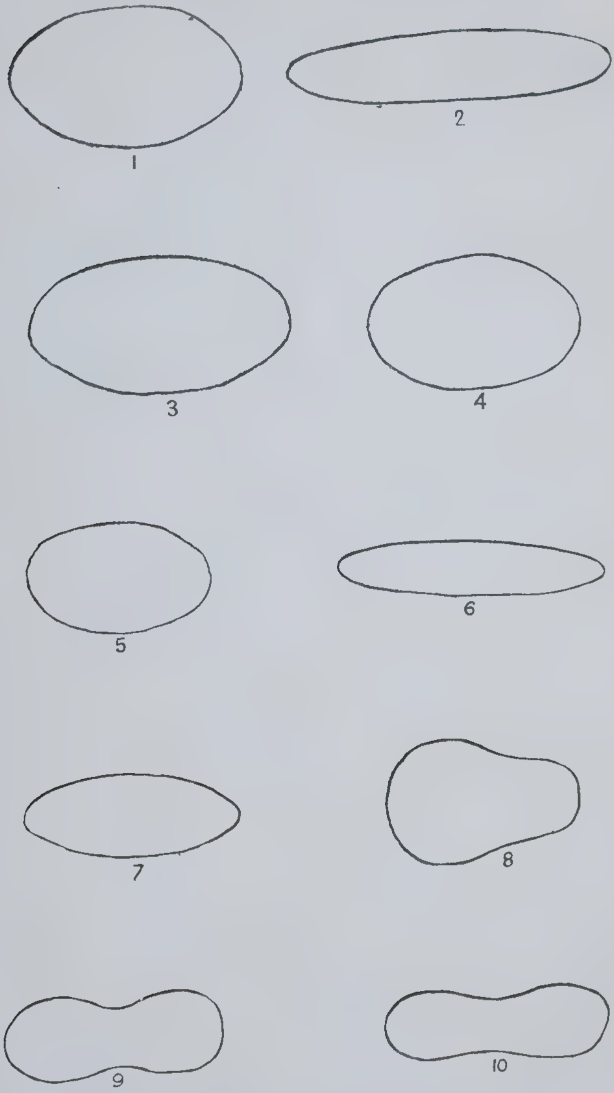


Fig. 4.



BUBBLES.

Fig. 1.—Reconstructed from Button after Dunn.
Fig. 2.—Reconstructed from Lens Button.
Fig. 3.—Reconstructed from Lens Dumb-bell.
Fig. 4.—Reconstructed from Conical Western Australian Form.



From Sir G. Darwin's book on Tides, etc.

Figs. 1 and 2.—Maclauren's Spheroids.

Figs. 3 and 4.—Jacobi's Ellipsoid.

Fig. 5.—Planetary Form coalescent with Elongated Form, just stable.

Fig. 6. Flat Unstable Form.

Fig. 7.—Limiting Maclauren's Figure.

Fig. 8.—Poincare's Figure.

Figs. 9 and 10.—Hour-glass Figure of Equilibrium.

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